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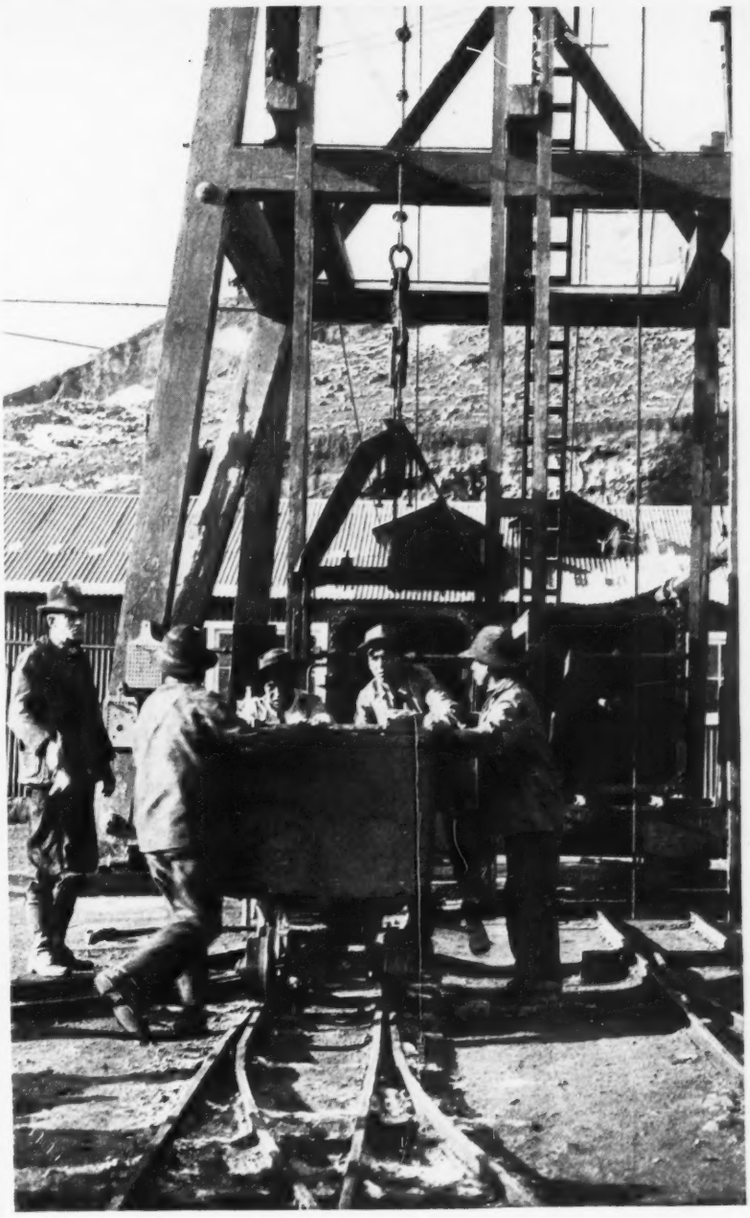

Shaft at Cerro de Pasco's San Francisco Mine, at Morococha, Peru

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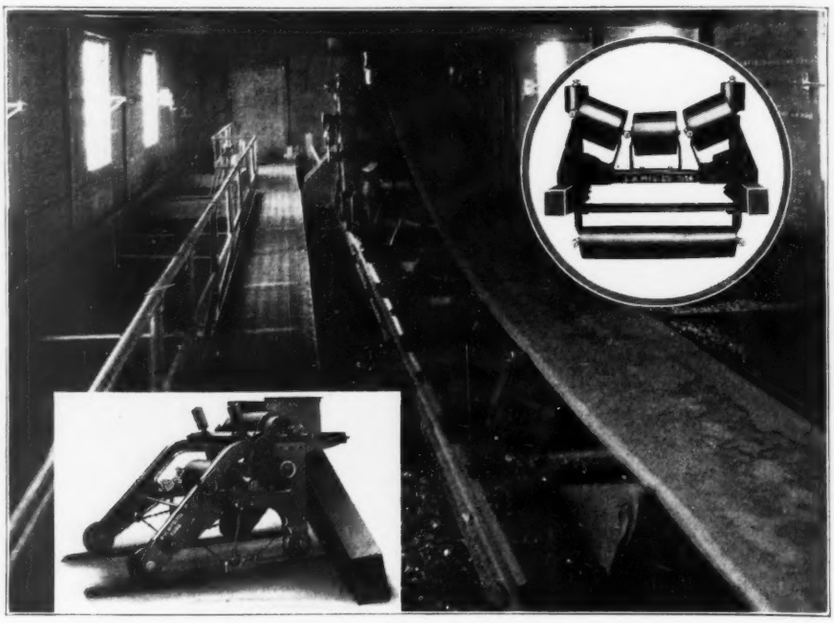

Belt conveyors—the modern method of handling materials

More and more the mining and milling industries are utilizing belt conveyors, and mechanical conveying is displacing other forms of transportation of ore and bulk materials. Recently Stephens-Adamson furnished a conveyor installation which measured over four miles in length!

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ENGINEERING AND
MINING JOURNAL-PRESS

JOSIAH EDWARD SPURR, Editor

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More Earthquakes

THE SERIOUS EARTHQUAKE in Santa Barbara, in southern California, following upon the heels of heavy earthquakes in Montana and neighboring states in the Rocky Mountain region, again calls the popular attention for a brief moment. Again the urge and the question comes: Why? The human mind is curious, and satisfied with almost any answer. The occasion of earthquakes is a blessing also for geologists who are consulted and quoted and their opinions broadcast in the press. Nowadays they usually point to some fault in the region of the earthquake; they assure the public that the earthquake was due to slipping on this fault, as they have long predicted and foreseen; and they conclude that now that the accumulated strain has been relieved by the slipping, the same region need not fear a recurrence of earthquakes for many years. It is as easy as 1, 2, 3. All this current geological patois arose out of the circumstance that at the time of the San Francisco earthquake there was movement along a certain fault.

Nevertheless, the current explanation is inadequate. In the first place, it remains to be proved that the slipping on the California fault was the cause, and not the effect, of the earthquake. Secondly, there are faults in great abundance throughout the whole Cordilleran region and the whole Appalachian region of the United States, and even a few in the Mississippi Valley region; and movement is progressing on thousands of these faults. The explanation of the geologist whereby he points to a certain fault after the earthquake, and blames the earthquake on it, is therefore usually unscientific. At the time of the recent earthquake that had its center in the St. Lawrence Valley, various prominent geologists pointed to various widely separated real or hypothetical faults with an air of proprietorship and finality.

The ancients believed that some giant was imprisoned beneath the earth and that from time to time he struggled, and the earth shook. It may be that, accepting the above as a figure of speech, they were not far from wrong. It may well be that earth tremors are as a rule due to various manifestations of the prisoned volatile elements of the earth—the telluric gases, migrating upward or outward, with unusual suddenness.

Earthquakes are allied to some extent with known vulcanism. Therefore they characterize the volcanic rim of the Pacific in the "circle of fire," whether in South America, Mexico, California, Alaska, or Japan; also the countries surrounding the Mediterranean, like Italy and Turkey; and other volcanic regions. Here earthquakes are common occurrences; but only the severe ones, with loss of life and property, are chronicled—giving thereby a false scientific basis of data. But the Charleston earthquake, and the recent minor shake-up in eastern Canada and New England, show that a region like the Appalachian zone, which has not had a volcanic outbreak since the Triassic, has also its crustal concussions and movements, even if rarer and as a rule less violent. In the Appalachian region, to be sure, there is geological evidence of crustal unrest that has been unceasing—general up and down movements of the whole crust; and even play of movement along fault planes.

The fact is that earthquakes cannot be foretold as eclipses can be. The public expects the geologist to do this; and the geologist is prone to seize the opportunity. But he knows more about the details of evolution than he does about earthquakes; concerning which it is altogether probable that they will never be foretellable—until after the event, as now. The population of the Eastern cities, especially the many-towered New York, would be glad for a definite opinion. There is none possible. One may point out that New York is safer than any city in the Pacific region, from Denver to San Francisco, and from Cape Horn to the Aleutian Islands. Concerning New York, the newspapers are saying that experts have pointed out that it rests on a secure foundation. To be sure it does—none better; but this rigid foundation constitutes an earthquake menace, should a quake occur. Better in that day for the man who has builded his house upon sand than for him who has founded it upon a rock. Safety lies in yielding to the vibrations; not in withstanding them. Wooden structures are safer than steel; steel safer than brick. A clay or sand foundation is better than rock; and yet not thoroughly safe, as the earthquakes in Mexico City have shown.

The real safeguarding against earthquakes would be to build close to the ground. It appears to be the tangential and torsional twist that makes havoc, as photographs of the Tokyo and other disasters show. The quake itself, in and at the surface of the earth, is ordinarily not dangerous, nor even highly notable. In the Tokyo disaster, no damage was done in mines; and the same observation now comes from Montana.

If one were obsessed with the earthquake danger, he should build a wooden bungalow in Florida; if he were looking for earthquake sensations he should live in a tall brick building near the Pacific.

News From Washingon

A CURIOUS TYPE of news has grown up in Washington within the last few years and has assumed large proportions. The center and type of this is in the office of the President of the United States. Mr. Coolidge, as did his immediate predecessors, receives the representatives of the press at regular frequent intervals and converses with them freely upon all subjects. However, it is understood that the President is not to be quoted. But what the correspondent may do and does is to rush an article to his paper saying, "One close to the President is reported to believe that" or "It is stated on high administrative authority that," etc., whereafter follow the President's views. This effect is, of course, understood by the President and on occasion utilized by him to disseminate views impersonally.

This habit has passed down to the Cabinet officers and from them to the bureau chiefs, and so on. Every man of these believes he is prevented by the dignity and responsibility of his position from giving out statements under his own name, but he allows and often formulates the publication of his views under the heading, "A widespread view of the subject is that" or "A prominent official in Washington stated that." Such news is apt to be accepted by the reader as having a broader base than the opinion of a single man, but in many cases it has only this origin.

The above analysis applies to the current news from Washington that is found in the newspapers. It also applies to the "News From Washington" sent in by the *Mining Journal-Press* correspondent. It is his job to report the acts and opinions of the administration, which he accomplishes by personal interviews, but he may not quote his information directly. Nor are the views advanced the personal views of Mr. Wooton. Those who would read between the lines must guess as to what official or officials have inspired them.

An Explanation From Mr. Doheny

MR. DOHENY'S story in the New York *Times*, July 1, of how the Elk Hills naval reserve oil lease came about and of how it happened that his company undertook to build the Pearl Harbor oil base in Hawaii for the navy is one of exceeding interest, though open to criticism on many points. Those who have read the accusation of misconduct in connection with these matters should in justice read his lengthy explanation. Unfortunately it comes late, whereas public opinion crystallizes quickly. A war secret was involved, he says, which fact has sealed his lips till now, when it seems, for reasons given, that secrecy is no longer needed. Unfortunately, too, the explanation is incomplete.

It was patriotism that made him enter on the project, at Rear Admiral Robison's appeal, he says. A war threatened in the Pacific, he was told, though few will readily believe this, which crisis was also responsible for the Armament Limitation Conference which then was on in Washington. It was in the brains of the officers of the navy, he says, that Harding's naval lease policy originated, and not with Secretary Fall. Denby, not Fall, he says, suggested the executive order of President Harding which gave the Interior Department, under Fall, administrative powers involving the naval oil reserves. Denby throughout was aware of every move, he intimates, and acted in more than simply a passive manner. Telegrams that would have helped clear the situation, but that were contrary to the theory of the prosecution, mysteriously disappeared from government files, he accuses. These messages he quotes. In all he puts the whole transaction, so far as he discusses it, in a light favorable to himself and Mr. Fall.

One thing only he avoids—and this, according to the *Times* correspondent, because his lawyers would not let him talk about it—namely, the matter of loaning $100,000 to Secretary Fall. Without this point cleared up the entire matter remains as much beclouded as at first. It is the point upon which the entire case has turned and in which it had its origin. Silence regarding it is natural, with the trial in Washington next October for criminal conspiracy with Mr. Fall hanging over Mr. Doheny. But an explanation that does not explain it might as well have not been made.

Franco-German Potash Combine

IN A RECENT EDITORIAL the reported Franco-German steel and iron combine was discussed. A further evidence of the tendency for big business to try its hand at solving this ancient Alsace-Lorraine feud is in the new potash combine. The potash fields of Alsace are the most important and productive in the world—they largely supply the world markets, and fix the world price. Before the war the potash fields were in German territory, and the industry was therefore under German control. By the result of the war much of the potash-bearing territory went over to France. Since the war, therefore, French and German producers have been competing, with the result of a low export price. It is now semi-officially announced that an agreement has been reached between the German potash syndicate and the French state and private potash industries. This agreement runs two years, during which France guarantees that its Alsatian potash industry will not enlarge the scope of its production; in compensation for this agreement Germany guarantees the maintenance of uniform prices between the French and the German industries. This will mean, probably, a higher export price, and will particularly interest and unfavorably affect the American farmer. Incidentally, it may help to solve the problem as to where France and Germany are to get the money that ultimately America demands in payment of war debts. To take it from America by a Franco-German monopolistic agreement is a sound business move. Moreover, the present export price of potash, due to Franco-German competition, is lower than German internal prices. The distribution of the world market will be on a basis of 30 per cent for France and 70 per cent for Germany; but each country will keep its home market for itself. Last year the German internal market absorbed 7,500,000 quintals of potash (1,650,000,000 lb.), while the French market used only about a tenth as much.

Simplification in Mechanical Installations

THE LOWERING of the cost of machine-cut steel gears by development of tools for quantity production was an important advance coming after the general introduction of electric motors and motor drives. The expansion in the use of gears was due not only to lower cost but to greater efficiency and improved mechanical design. The compact motor-driven hoist was made possible by the availability of high-grade gears. Two other devices have been so improved in both mechanical arrangement and lowering of production costs that they have greatly influenced mechanical design and have resulted in a simplification of milling installations. We refer to the speed reducer and the short belt drive.

The speed reducer has eliminated countershafts with their long belt drives and has reduced to a minimum the accident risk to attendants. The short belt drive has also obviated countershafts. The installation of crushing rolls hitherto involved difficulty in the driving arrangements, as it was necessary to use an open belt and a crossed belt for each set of rolls driven from the countershaft. This gave a multiplicity of shafts and belts that apparently could not be avoided. The large modern roll set is now driven by two motors and short-center belts with tighteners. The result is greater compactness, higher driving efficiency, fewer lubricating points, and a safer operating unit.

Ball and tube mills are now driven by high-speed motors by means of a speed reducer interposed between the motor and the main driving gear. Bucket elevators and apron plate feeders are direct driven by the motor-speed-reducer unit and all driving belts and countershafts are avoided. In the Warren mill of the Phelps Dodge Corporation, concentrating tables were equipped with individual motors of the back-geared type, thus removing the overhead shaft with its belts and hangers.

Belt drives cannot be wholly avoided, as practically all coarse crushing units, such as jaw crushers, gyratories, disk crushers, and rolls, are best driven by belts. This arrangement provides for the contingency of sudden stoppage due to tramp iron. The last-named difficulty is to a large extent minimized by the use of magnetic pulleys and suspended electromagnets.

Electrical power distribution has been the most important element resulting in simplification of plant design. The speed reducer and short belt drive have advanced simplification further. The economic result is important: fewer operators, fewer delays, less power, less supplies, and safer operation. The last stage in this important progression is the use of automatic lubrication for many of the machines and for others the use of thick lubricants applied by pressure through a pipe system. This has improved the efficiency of lubrication and has overcome the difficulties arising from the neglect or forgetfulness of oilers.

Continuous Conveyors Underground

MORE AND MORE the economical moving of material is becoming a major problem in the mining industries. As the richer orebodies are being exhausted, reliance must be placed on the exploitation of low-grade deposits. This means more ore handled to produce an ounce or a pound or a ton of metal. Even in the metallurgical treatment of the ore —whether concentrating, leaching or smelting—the processes themselves have been developed to such a dergee that room for increasing recoveries is small; consequently greater attention is being paid to the reduction of costs by improving methods of mechanical handling of raw, semi-finished, and finished products. The movement may be either from plant to plant, from department to department, from one piece of equipment to another, or through a particular machine. Cheaper handling, nine times in ten, means more and better equipment. The increase in wage scales, of course, has been an important factor, but even in foreign countries where wages are low, mechanical handling generally has been found cheaper in the end.

On page 45 of this issue is an article on the possibilities of using continuous conveyors underground in metal mines. The discussion, necessarily, is speculative in a large measure, because so far as is shown by casual search of current literature and wide inquiry in the industry, there are no important installations of conveying equipment in American metal mines.

The fact that coal-mining companies during the last few years have effected remarkable reductions in production costs by using continuous conveyors is by no means conclusive evidence that metal miners are overlooking an opportunity. Obviously, conditions in coal mines are quite different from those found in most metal mines. Nevertheless, in view of the admitted virtues of continuous conveyors in mills and smelters and of the recent advance made by manufacturers in designing and building conveying machinery, the question of the use of such equipment underground deserves careful study by managers of metal mines. *Mining Journal-Press* will be glad to open its discussion columns to those with something to contribute on the subject.

Anaconda's Montana Operations Looking Up

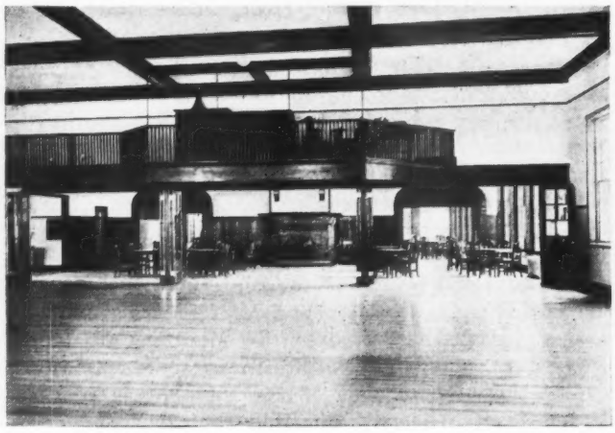
IT WAS NOT SO LONG AGO that a few pessimists expressed their doubts as to whether Anaconda would continue to operate its Butte properties. Copper could be produced so much more profitably in Chile, they argued, that it would pay the company to expand its output at Chuquicamata and develop the Andes property rather than to trade new dollars for old in Montana. But the operations of Anaconda for the first half of 1925 indicate a new lease of life for the Butte mines, and the prospects for continued and increasing activity there are better than for many years.

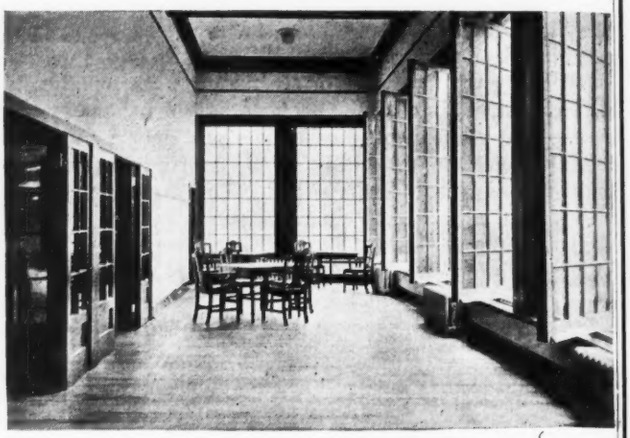
Costs of producing copper in Montana are, and always have been, merely conjectural so far as any one except the high officials of the company is concerned. It has been generally admitted that Anaconda was a "high-cost" producer, meaning that the price of copper would have to be 15c. or more for the company to make much money. Statements recently appearing in the press, however, and probably of a semi-official nature, indicate that the cost of producing copper, after allowing for taxes and depreciation, is about 9½c. per lb. This, however, is calculated by crediting timber, coal, and several other unnamed products of the company at the ruling prices in Montana. As the company has so many other irons in the fire, it is conceivable that the cost of producing copper might be brought down to an absurdity by this method of figuring, but the fact remains that the combined operations are profitable, which is what the stockholders want to hear.

Several factors are responsible for the good news. To begin underground, better selection of ore is practiced and mines producing the poorest ores have been closed down. Instead of 3 or 3½ per cent ore going to the mills, the average is probably now 4 per cent copper or better. Fires have all been extinguished and an elaborate ventilation system installed, thus promoting efficiency. In the mills, the use of xanthate in an alkaline circuit has improved the metallurgic and economic results. Improvements have been made in the smelter and refineries, especially in the zinc department at Great Falls. Increased production has also contributed to lowered costs; from its own mines, Anaconda's copper production was said to have reached more than 22,000,000 lb. a month, though it has since been decreased, according to reports, to around 18,000,000,000. About 15,000,000 lb. of zinc is produced monthly at Great Falls, although only a small proportion comes from its own mines. This is the highest grade, which commands 1½c. premium over Prime Western. Better prices for metals have also helped Anaconda's Montana operations: copper, in the first six months of 1925, has averaged 14.1c. per lb. delivered, compared with 13.3c. for the year 1924; zinc, 7.2c., compared with 6.3c.; and silver, 68.0c., compared with 66.8c.

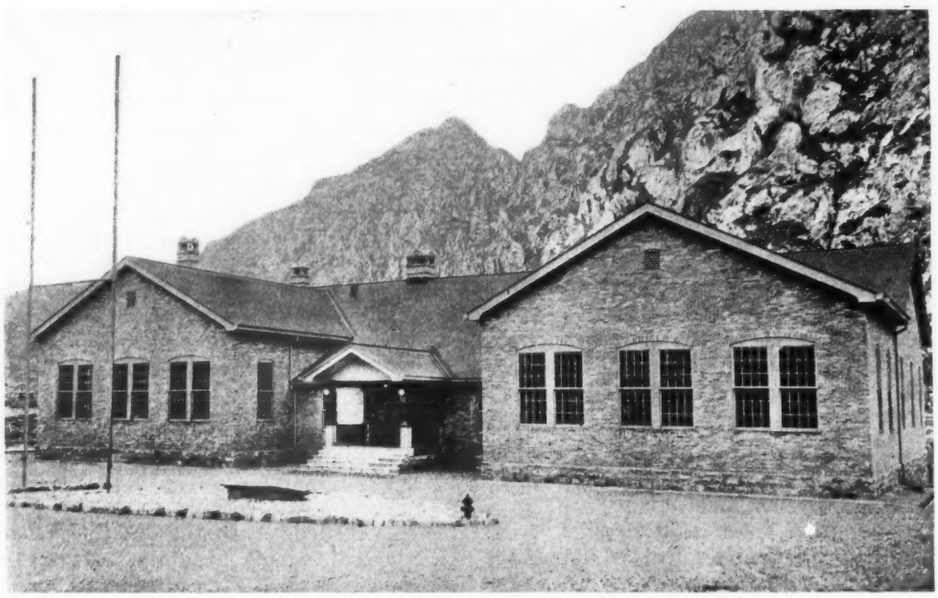
The mines at Butte will last a long time yet. The deepest mine is now close to 4,000 ft. from the surface and the veins are practically the same at depth as on the upper levels. A big extension of the working area may be expected to the northwest, and some good zinc ground is being opened up. Those interested in Anaconda's prosperity have every reason to feel encouraged.

Clubhouse for Cerro de Pasco's Smelter Staff at Oroya, in the High Andes of Peru

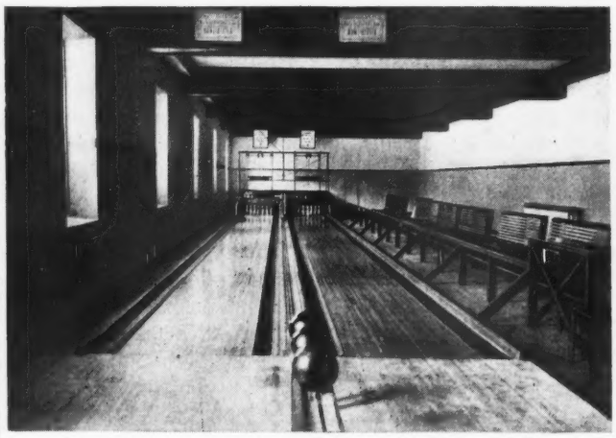


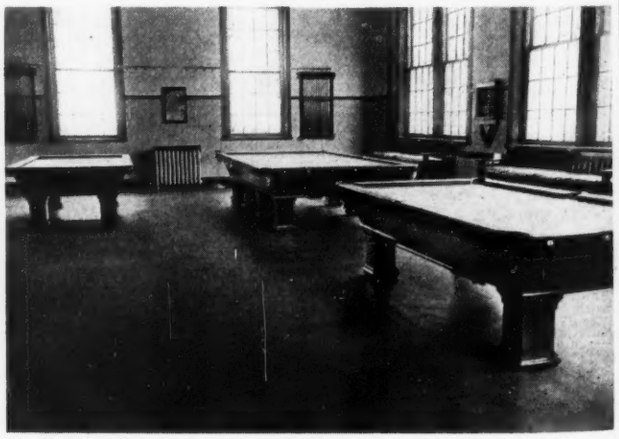


The ballroom, auditorium and music room, on the left. Right, the sun parlor



The building with its mountain background





Bowling and billiards, which are provided as diversions, are appreciated in this isolated region

Has the Continuous Conveyor a Place in Metal Mines?

Recent Introduction in Coal Mines Has Effected Great Economies—Operators Know Advantages of Use in Mills and Smelters—Can It Cut Ore-Moving Costs Underground?

By Arthur B. Parsons
Assistant Editor

PROBABLY no kind of equipment is in more nearly universal use than mechanical conveyors of the continuous type as a means of moving ore after it has reached the surface. Pan or apron, and rubber belt conveyors to a remarkable extent, have displaced transportation by car in crushing, milling, concentrating, leaching, and smelting plants. On the other hand, use of equipment of this kind is almost unheard of underground in metal mines in the United States. If the question is asked of the average metal mine manager, "Under what conditions, if any, do you think saving might be effected by using mechanical conveyors underground?" he will almost surely give you a number of reasons why the plan would be impracticable under the conditions prevailing at his mine. I feel safe in making this statement, because the *Mining Journal-Press* asked the question of about twenty of the leading mine managers in the United States and the written replies are before me. This is to be expected as a corollary to the fact that conveyors are not in use. The progressive manager has necessarily given the question at least casual consideration, in view of the recognized economies effected in surface operations. Since few of them have even given the scheme a trial, it follows that the obvious disadvantages have outweighed the advantages in any particular case. At the same time, many of the letters outline conditions under which the writers feel that conveyors would prove practicable and economical.

Problem Deserves Careful Study

A number of considerations suggest the possibility that conveyors might be used underground in many places, or, at least, that the mine managers might well study the problem more carefully. Among these are:

(1) The general opinion that I have just mentioned, that conditions exist in metal mines where conveyors might be used profitably.

(2) The increasing scale of operations because of the need for mining lower-grade ore in larger tonnages to meet the demand for metal. A conveyor belt has a large capacity and constant use is a factor in its efficiency.

(3) Higher wage scales, which magnify the advantage of decreasing the number of workers.

(4) Improvements in the design of light portable rugged conveyors that are sectionalized for flexibility of operation; and improvements in the construction of belts, idlers, and transmission equipment for permanent installations.

(5) The remarkable success attained in coal mining by the use of conveying equipment underground. There are, of course, special conditions in coal mines that make the process particularly applicable. Metal mine operations, however, are similar in sufficient degree to warrant some study of coal-mine conveyors.

In this article I shall first outline some of the work now being done in coal mines; then enumerate the disadvantages, principally as pointed out by the writers of the letters already referred to; and, finally, endeavor to suggest conditions under which there seems to exist the best chance for advantageously using conveyors in metal mines.

There are really two fairly distinct phases to the problem, whether coal or metal mines are considered. First, there is comparatively long-distance conveying in permanent haulage ways. For this, rubber belts only are suitable. Idlers hung on ball bearings, running in oil or other lubricant, highly efficient motive and transmission machinery, and interlocking controls may be provided, the object being to afford dependable, rapid transportation of large tonnages at minimum operating cost. Second, what may be called "primary" or "face" conveying, whereby the ore or coal is loaded near where it is broken originally and delivered to cars, conveyors, or chutes. In metal mines, waste might be transferred from a chute to the "fill." The essential point is that the conveying equipment must be portable and flexible. Continuous rubber belts or steel pans, or conveyors of the scraper type may be used. The latter consists of a sheet-metal trough in which scrapers attached to a continuous moving chain push the material along.

In coal mines, the motive power in this country generally has been electricity; but in England, compressed air is often used for the so-called face conveyor. It might well be that air would be the most desirable form of power for the smaller conveyors if they were to be used in metal mines, because of its general availability in working places. Fairly efficient air motors of 5 to 10 hp. are obtainable, and they are reasonably foolproof.

The classic example of a conveyor of the first type is that at the Colonial mine of the H. C. Frick Coke Co., where 9,000 tons of coal per 8-hr. day is carried 4¾ miles from a central underground loading station to a series of elevated bins, from which barges are loaded on the Monongahela River. The following data show some of the features of the installation:

Number of belts	20
Number of belt carriers	6,598
Width of belt (8 ply; ⅜-in. top, 1/16-in. pulley cover), in.	48
Carrying length of belts, ft.	27,927
Total length of belting, ft.	47,080
Shortest section, ft.	321
Longest section, ft.	1,514
Net rise from feed hopper to mouth of mine, ft.	357
Speed of belt, ft. per minute	500
Capacity of belt, tons per hour	1,500
Electric motors (20) General Electric, total hp.	2,850
Total running power, hp.	1,933

Falk reduction gears, Stephens-Adamson ball-bearing troughing and return idlers, and Hyatt high-duty bearings for herringbone gears, are important parts in the equipment. An intricate system of automatic control prevents the belts from starting or stopping in the wrong order, this control being sensitive to a variation of as little as 10 per cent in the normal speed. The belt which first receives the coal is 60 in. wide and is fed by thirty-four apron feeders driven by a single variable speed motor.

The plan first considered was transportation by elec-

tric locomotives, and according to Thomas W. Dawson, chief engineer, this method would have been adopted had it not been for the fact that there was room for only two tracks in the passage that was available. However, Mr. Dawson concludes an article in *Coal Age* for Dec. 25, 1924, with this paragraph: "Summarizing, it has been found that a conveyor is dependable in its operation; positive in its performance; durable to an extent greater than most machines; less hazardous to life; and not entirely dependent upon the human element. It requires few men to operate; is not excessive in first cost; and has low operating charges."

Moreover, I understand that two similar installations are planned for the immediate future by the H. C. Frick company, which answers in the best possible way the question as to whether the Colonial project is a success.

In an article in *Coal Age* for Oct. 23, 1924, Milton H. Fies, vice-president of the De Bardeleben Coal Corporation, describes a belt installation as follows:

"At one mine in Alabama, a belt is used for hoisting coal up a slope. The conveyor operates on a pitch of 19 deg. 53 min. The belt is 4 ft. wide, with troughing idlers on the upper, and straight bearing idlers on the lower strand. Head and tail centers are 485 ft. apart, and the belt is kept taut by passing over an idler pulley to which a counterweight is attached located just under the head pulley. The coal is discharged in a one-car revolving dump underground. Under this dump is a hopper, which holds about 6 tons, or the capacity of three mine cars. Beneath the hopper is placed a reciprocating feeder, which feeds the coal from the hopper to the belt. This feeder is perforated, and the slack coal goes to the belt first and the lump coal is deposited on top of it. The belt has a capacity of 2,500 tons per day of 8 hr. A 75-hp. motor drives this conveyor as well as the reciprocating feeder. The advantages of this system are reduced cost of all tipple and headframe structures, a lower operating expense, a smaller investment in hoisting machines—a 75-hp. motor as against an expensive hoist of 500- to 700-hp. capacity. By regulating the feed at the bottom of the slope, coal can be fed to the shaker screen in the tipple with such regularity as to make the screening highly effective, and all danger from slope trips is eliminated.

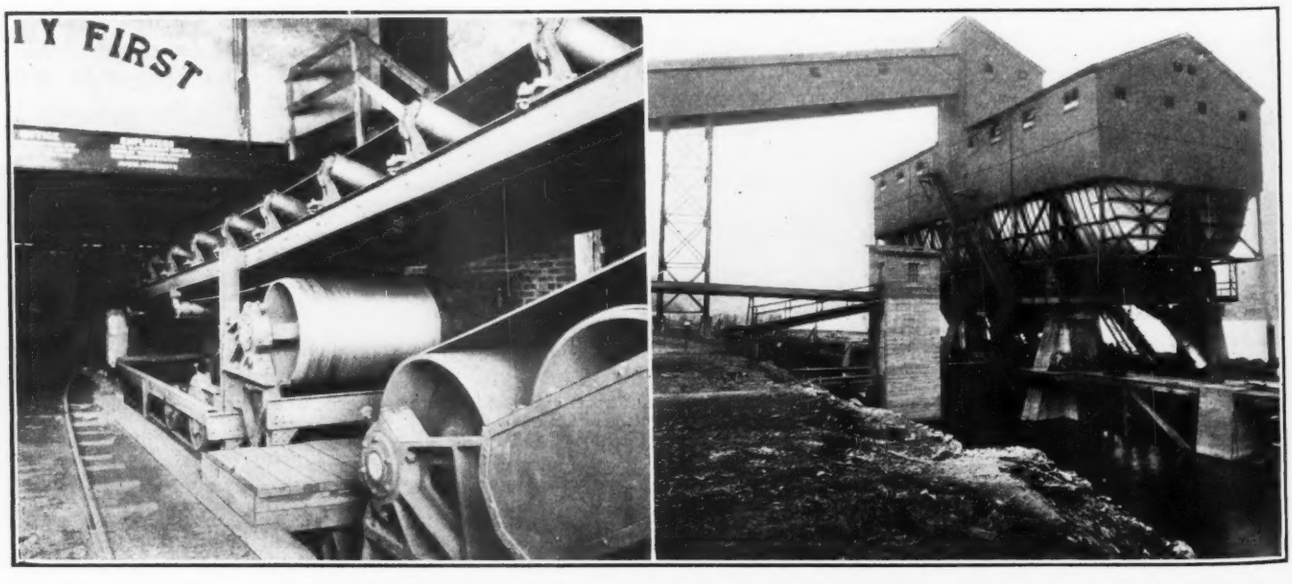
"This belt has been in operation about a year, and no wear is noticeable. The mine has not been brought to its full capacity, but 1,100 tons have been handled over the conveyor in one day with the belt standing idle about half of the time."

Next comes the use of self-contained portable or sectionalized conveying machines at or near the face. Delay involved in waiting for cars, to some extent when loading is done by hand, but more particularly when loading machines are used, has been the biggest factor in stimulating the development of these machines. The advantages of a continuous conveying system in coal-mining operations may be summarized as follows: A loading machine is kept busy, thereby obviating the loss of capital cost and of the wages of the operators involved in wasted time. The output of a given room or group of rooms is increased, thereby allowing the concentration of operations in a small area for a given output, thus cutting the cost of supervision. Rapid advance in a room makes for safe mining, saves timber, and permits a higher recovery of the coal. Continuous and uniform output permits efficient scheduling of mine haulage. The output per worker, especially where machine loading is used, is greatly increased, thereby cutting the overhead cost per ton of coal produced.

For the purpose of conveying from the face where the coal is broken, several machines have been developed. One is the Movor conveyor, shown in the illustration on page 48. It is of the pan-belt type, built entirely of steel, and portable because it is sectionalized. Standard units are 6 ft. in length. The machine, described in *Coal Age* for May 8, 1924, is simple in design and rugged in construction, and two men can carry the heaviest part. The article says:

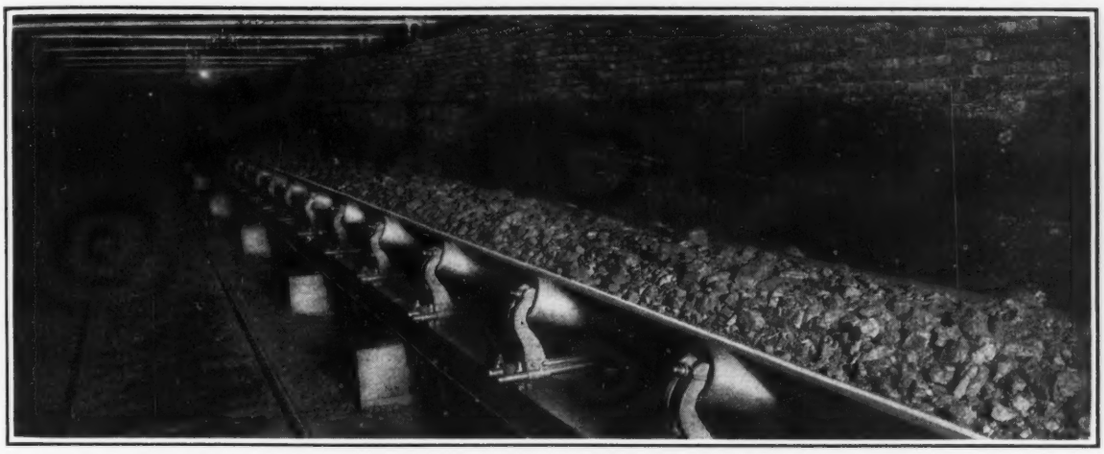
"The two primary objects sought were low maintenance cost and the expenditure of the least possible time and effort in assembling or dismantling a unit. . . . A unit must comprise four parts: a head, a curved, a drive and a tail section. As many straight sections may be added as are needed to secure the desired length. If, however, the number necessary is more than can be actuated by one drive section, additional drive sections may be added at will.

"All sections, except those forming the head and tail



At the Colonial mine of the H. C. Frick Coke Co.

Left—Tandem drive and take-up station near the entrance to the mine. Right—Docks and bins into which the conveyor discharges and from which barges are loaded.



Long 48-in. conveyor in the Colonial mine

Note the absence of any spillage. The belt travels 500 ft. per minute and carries 1,500 tons per hour. The idlers can be turned over on the deck for cleaning and oiling.

of the conveyor, are interchangeable, so that a unit of any length may be built up. If greater rise is required at the delivery end than is afforded by the curved section, one or more straight sections may be interposed between it and the head section, so that any height of discharge may be attained.

"In short, the design of this conveyor is such that great flexibility is obtained. All motors normally used for driving the conveyor on level ground, regardless of its width or capacity, are of 5 hp. Such a motor is capable of actuating about 100 ft. of 20-in., or 70 to 80 ft. of 36-in. pan belt. Conveyors longer than those mentioned require two or more drive units, each operating independently of, but in synchronism with, the others.

"Each section of this conveyor is complete in itself. This greatly facilitates the assembly or transportation of a unit. Two elements are common to all sections—namely, the frame (the shape of which differs for each type of section) and the pan belt, which is of standard design and common to all sections. The frame elements are built up of angles and plates securely riveted together. They are joined end to end by means of slotted pins fitted with wedge-shaped keys. . . .

"For use in rooms and other places where the quantity of coal to be handled does not exceed 100 tons per hour, the conveyor pans are 20 in. wide, 4 in. high, and have a pitch of 9 in. Such a conveyor has a calculated capacity, when carrying loose coal, of 1 ton per hour for each foot of conveyor travel per minute. At a speed of 100 ft. per minute, therefore, such a conveyor has a calculated capacity of 100 tons per hour. In performance, however, the capacity actually obtained is somewhat greater than this. For ordinary use, the speed of travel is reduced to 50 ft. per minute, giving a corresponding capacity of 50 tons per hour."

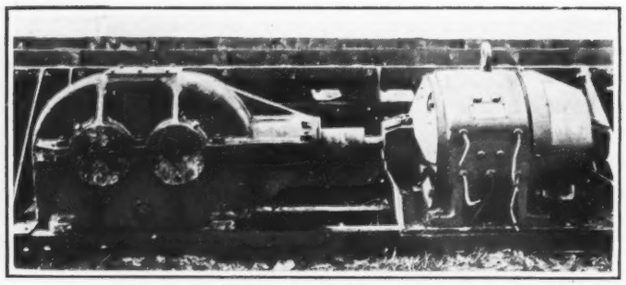
Another type of conveyor much used in coal mines is the trough and scraper. The illustration on page 49 shows such a conveyor, built by the Jeffrey Manufacturing Co. Here again the portability and ease of lengthening are cardinal features, as are simplicity and low cost. The machine can be built with a maximum height of only about a foot and is used among other places in thin beds. The Glen Alden Coal Co. works a 30-in. seam with these conveyors, the loading being done entirely by hand, the shovelers working on their knees. Details of the construction and operation of this device are given in *Coal Age* for Oct. 16, 1924.

So far as I know, rubber belts have not been used for these portable conveyors in coal mines. One objection advanced is that sectionalizing would be more difficult. However, it would seem that this could be overcome by careful designing, and it is likely that a practicable machine using a rubber belt in sections will be made.

In this connection it seems possible that a narrow belt with sheet steel "sides," as used in a few mills, and, I believe, underground in Australia, might find application. The carrying idlers are flat, and along each side of the belt are bolted short (4 to 6 in.) sections of sheet steel angles, thereby forming a trough 4 or 5 in. deep and as wide as the belt. As the sides are sectionalized, the belt conforms readily to tail and head-pulleys of comparatively small diameter; and the capacity of the device is much larger than that of a belt of the same width, operating on troughing idlers. One of the objections advanced to the use of rubber belts for face conveyors in coal mines has been the difficulty in devising a quickly made, durable and flexible belt splice that would not interfere with the troughing. With a conveyor of the type just mentioned, no troughing is wanted, so that there would be no difficulty on that score.

A "face" conveyor may deliver its load either to cars in a main haulageway, where traffic arrangements are such that only momentary delay is occasioned by the necessity for pushing the loaded car ahead to be replaced by an empty; or it may deliver to another conveyor. Frequently a large number of pan-belt conveyors feed a rubber belt conveyor used as a collector. This may deliver to main line cars, or it may be followed by a belt conveyor system that carries the coal out of the mine to the standard railroad car for shipment or to the tipple for screening or washing.

The coal-mining companies unquestionably have proved the advantage of using continuous mechanical conveyors in their operations. The moving of ore in metal mines presents a somewhat different problem, of course. The extreme variant is probably found in the average vein mine, where comparatively rich ore is won in small tonnages by methods involving more or less selective mining. From this, by successive steps, an approach to the methods of coal mining may be observed in various types of operation: larger orebodies with lower and more uniform grades of ore; then, bedded deposits of uniform character that lie nearly horizontal.



A drive section of the Movor conveyor

One or more of these sections can be inserted in the conveyor, depending on the length and power required.

These present mining problems similar in many respects to those of coal mining. Especially in the non-metallic branch of the industry may ore-winning methods resembling those used for coal be cited, as for instance gypsum, salt and limestone. Iron mine operations are frequently similar to coal mining in so far as the character of the deposit is concerned. However, in the present inquiry, principal consideration has been given to the typical non-ferrous metal mining. If any opportunity for using continuous conveyors can be found in them, the opportunity in mines that more nearly resemble coal mines should be correspondingly greater.

The objections to the use of conveyors that have been advanced by the mine managers consulted are various. Boiled down, the objection, of course, is that the cost when using conveyors would exceed the present cost of moving the same ore by means of cars and tracks, or, in some cases, by means of wheelbarrows.

Following are some of the operating difficulties that would help run up the cost of using continuous conveyors, being in substance the ideas of the managers. Obviously, all of these do not apply to all kinds of metal mines. Answers may be given to many of them; but here they are:

(1) Difficulty of feeding. Run-of-mine ore from stope chutes would be hard to feed rapidly and uniformly.

(2) Damage to belt. The ore usually contains large, sharp, angular pieces that would be likely to injure the belt.

(3) Difficulty in repairing haulageways. The presence of the belt would interfere with the work of maintaining drifts. Sections of the belt might have to be removed when slabbing from the back, and haulage would be interrupted. Replacement of timbers might be more difficult than under present conditions.

(4) Interference with haulage of supplies. Even if the belts were reversible to carry tools and supplies to the working places, the transportation of large and heavy timbers, for instance, would be a problem. It might be necessary to parallel the conveyor ways with drifts for hauling supplies and in some cases for carrying men to and from their work. This would be an added expense.

(5) Crookedness of drifts. When the original drift is run on the ore, it frequently must be crooked. A conveyor would be impracticable under such circumstances.

(6) Difficulty in maintaining alignment. In ground where swelling and subsiding is continually taking place it would be difficult and costly to maintain the conveyor in efficient operating condition.

(7) Necessity of providing storage pockets. Hoisting of cars in cages is practiced often because the cutting of a storage pocket would weaken the shaft. A pocket and skips would be almost indispensable with a belt delivering to the shaft station.

(8) Difficulty of keeping a conveyor working at or near capacity. This is probably the most important objection. The following condition characteristic of metal mines is significant.

On account of the irregularity in character or grade, or on account of the limitations of production from any one stope, or because of the necessity for keeping development ahead on various shoots, ore is generally being drawn simultaneously from many places in a metal mine at a given time. Where there are different levels, several contribute to the output.

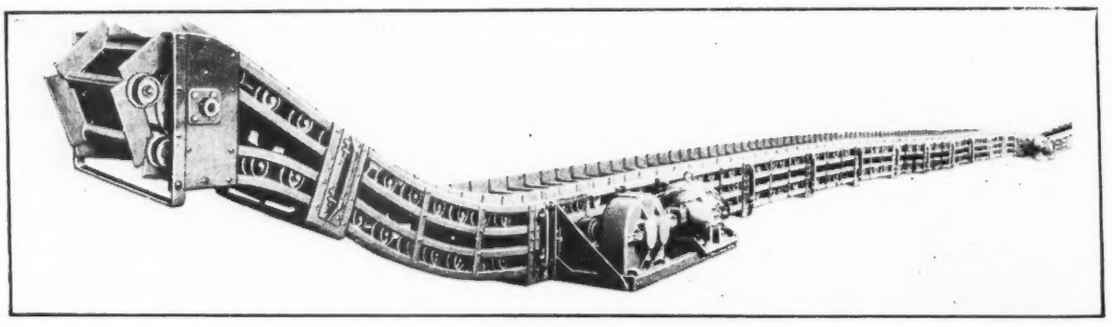
Consequently it may be impracticable to concentrate production in a small section of the mine and supply enough ore to keep a conveyor belt in comparatively constant operation. The conveyor essentially is a "large-tonnage" device, and where you cannot supply the large tonnage, it loses some of its attractiveness.

A comparison of a conveying system with any other means of moving ore involves an estimation of the following items of cost for each:

Capital investment for equipment.
Interest charges.
Depreciation.
Cost of installing.
Cost of operation:
- (*a*) Labor.
- (*b*) Power.
- (*c*) Sundry supplies.
- (*d*) Renewal parts.
- (*e*) Labor for current repairs.

The manager of one mine has compared the capital cost of a belt conveyor and a track-and-car installation as follows:

"The cost of idlers and belt, assuming that a 24-in. belt would be of sufficient width, is about $14.25 per foot, without any charge for installation, or for a



Movor portable all-steel conveyor

A feature of this machine is the simplicity of construction, which permits the sections to be taken apart, moved, and reassembled quickly.

3,000-ft. level about $42,750. This compares with $3 per foot for our present 35-lb. track, which, with additional equipment in the form of locomotives and cars of about $12,000, makes the total cost for the 3,000 ft. about $21,000." The cost of installation would be higher for the belt, but the maintenance cost ought to be lower. The operating cost should easily favor the conveyor system. The maximum production on the level for which such a conveyor system is suggested in this instance is 400 tons per day. The belt probably could handle several times as much in two 8-hr. shifts if it were kept busy. However, 400 tons per day is larger than the production of the average metal mine from a single level.

This seems to be a rather formidable array of objections to be overcome. And yet conditions are conceivable under which a conveyor system might deserve serious consideration, particularly if such an installation were planned beforehand and the underground workings laid out with the end in view of using belts.

Any place where a long crosscut is to serve as a permanent haulageway for a large volume of ore would offer such an opportunity. Here are a few sets of conditions:

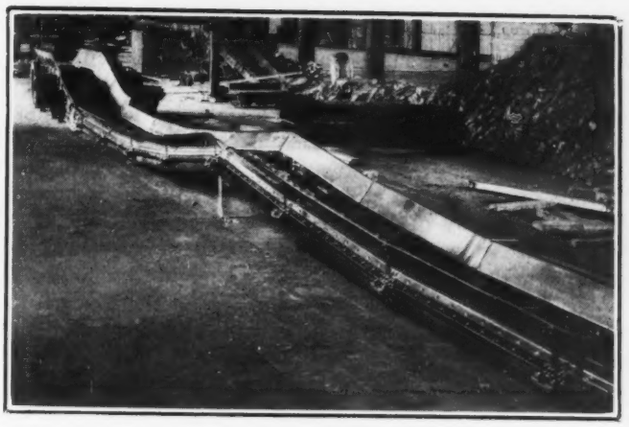
(1) A mine worked through a crosscut adit, at the end of which is an internal shaft hoisting a large tonnage from lower levels. An example is the Morning mine, in the Coeur d'Alene district in Idaho. The output is only about 1,000 tons per day, which might be too low to warrant the installation.

(2) A long crosscut haulageway delivering to a vertical shaft for hoisting. The Star crosscut to the Hecla shaft in the Coeur d'Alene district and the eighty-first level haulageway of the Calumet & Hecla company in the Michigan copper country meet this condition.

(3) In a comparatively shallow mine producing a large tonnage it might prove practicable to drive a slope with a pitch of less than 22 deg. and makes use of an inclined conveyor belt to do away with the necessity for operating a hoist in a vertical shaft. A series of belts might be used to collect and deliver the ore to the main "hoisting" belt, or an underground coarse crushing plant might be provided so as to make the feeding of the belt more economical and satisfactory, and at the same time reduce the wear on the belt. A large low-grade deposit of shallow depth like the zinc mines at Mascot, Tenn., could conceivably be worked through such an incline, the strong dolomitic formation being an advantage in that the maintenance of the conveyor-way would be inexpensive. Some of the low-grade copper deposits might even offer possibilities in this direction.

(4) Companies mining bedded deposits with a dip of less than 20 deg., now worked through inclines with track and car haulage, might advantageously adopt a conveyor system as a means of carrying the ore through the main outlet of the mine. Supplemental belts on various levels might be used to feed directly onto the main belt. The iron mines in the Birmingham district are examples of this type of deposit.

The foregoing are cited as offering problems comparable to that of the H. C. Frick Coke Co. at the Colonial mine—that is, permanent large-capacity hauling in which the greater part of the mine output is moved between established stations. Generally an essential consideration would be the transportation of men and supplies into the mine. If the operations were large enough, special arrangements either through other entries or by means of a light car-and-rail system paralleling the belt conveyors could be provided.



Trough and scraper conveyor

Scrapers, attached to an endless chain, push the coal along the trough. "Humps" on the floor are not an obstacle.

The other phase of the question concerns the use of portable mechanical conveyors, adaptable, if at all, to work near the face where ore is being currently broken. Some of the conditions under which conveyors might be considered are:

(1) In connection with loading into mine cars or buckets by hand shoveling. In a large open stope such as those found in the Joplin-Miami zinc-lead mines a pan-belt machine similar to one of those described as used in coal mines, or, preferably, a mounted conveyor of the type used to load sand, gravel or coal from stock piles into railway cars might find place. The advantages would be that the feed end of the conveyor could be swung around to the particular point on the "muck" pile, and that, being low, the lift on the part of the shoveler would be minimized. Time would be saved in laying and shifting track, and two shovelers ought to keep the loading machine reasonably busy.

(2) In an inclined orebody too steep for the convenient operation of cars on tracks and too flat for the ore to flow of its own accord, sectional conveyors in connection with hand loading might be used to good advantage to move the ore down or even up the stope.

(3) Where mechanical loaders are used, the need for steady operation is important so as to make the most out of the capital investment represented by an expensive machine, which, unlike a worker who shovels by hand, does not need periodic rests. Under some conditions it is possible to keep a supply of empty cars available directly at the loading machine so that little time is lost, but, as in coal mining, this is often impracticable in metal mines. There seems to be a chance here for the short conveyor belt to supply a link between the advancing face and the comparatively permanent system of rail transportation.

(4) Another suggestion is that a light portable conveyor, probably run by an air motor, could be used in square-set stoping in wide veins. It might serve first to carry broken ore to the chute, and subsequently to fill the stope, drawing from a waste chute and delivering to the sets to be filled in the floor beneath. A light conveyor would be little more difficult to move and set up than the tracks and cars that would be used as an alternative.

This does not by any means exhaust the possibilities of finding application for continuous conveyors underground, but it should serve to start speculation on the

Vanadium in Iron Ores and Its Extraction

Commonly Associated With Titanium and Phosphorus—On Smelting, Practically All Enters Pig Iron, From Which It Is Easily Slagged and Concentrated

By Rutger von Seth

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VANADIUM was discovered in 1830 by Sefström in wrought iron from Taberg in Sweden. Thereafter, the presence of vanadium in iron and iron ores had little attention for a long time, notwithstanding that Sefström attributed the good quality of this wrought iron to that element. Vanadium was first practically used about 1870, in dyestuff manufacture. At first, Spanish lead ores containing vanadium were used for producing vanadium, but after 1882 Thomas slag from the French steel works at Le Creusot[1] was also used. These slags contained 2 per cent V_2O_5 or less. The annual production for this purpose was about 60 tons of vanadium. The investigations on vanadium steel made by Arnold and others at the beginning of this century started a great search for vanadium ores, which resulted in the utilization of the deposits in South America, Colorado, and elsewhere. The price of vanadium decreased quickly, and the production of vanadium from Thomas slag no longer paid. During the World War a similar process is said to have been tried in Germany—for instance, at Dillinger Hütte, where slags with 0.7 per cent vanadium were used.[2]

However, the presence of vanadium in iron ores has been more and more noticed recently on account of its advantageous influence on pig iron and steel, and this circumstance has resulted in an increasing demand for vanadium, mainly owing to the enormous development of automobile manufacture.

In this article I shall make a summary of some investigations on ores containing vanadium, and give an account of the behavior of vanadium in the furnace processes, and of the experiments hitherto made to extract vanadium from iron ores. Finally, a new method will be suggested for economically extracting vanadium from ores of low-vanadium content.

I. Iron Ores Containing Vanadium

Germany, France, and Luxemburg. The presence of vanadium in the Thomas slags at Le Creusot and Dillinger Hütte, where it comes from the oölitic ores ("minettes") rich in phosphorus, has already been mentioned. The presence of vanadium in these ores was also noticed by L. Blum.[3] At Esch a.d. Alzette, Blum made an investigation of the presence of vanadium in the "minettes," and its behavior in the Thomas process. He gives the following contents of iron and vanadium in different "minettes":

	Fe, Per Cent	V_2O_5, Per Cent
Bouvenberg von Redingen	37.49	0.182
Vereinigte Hüttenwerken von Belvaux	36.75	0.182
Victor in Hayingen	29.64	0.126
Lallingerberg in Eich	25.63	0.169
Langengrund in Rümelingen	31.86	0.182
Brommeschberg in Tetingen	29.41	0.156
Esch-Hoehl, red siliceous bed	29.00	0.163
Esch-Hoehl, red calcareous bed	27.44	0.133
Esch-Hoehl, gray bed	30.52	0.121
Esch-Hoehl, brown bed	42.43	0.169
Esch-Hoehl, black bed	41.34	0.194

[1] *Berg- und Hüttenmännische Zeitung.* 1893, p. 444.

[2] According to Krusch: Die Untersuchung und Bewertung von Erzlagerstätten.

[3] *Stahl und Eisen,* 1915, p. 16.

The most important German iron ores after the war, the oölitic ores in Hannover worked by the Ilseder Hütte, also contain vanadium. Thomas pig iron produced from these ores contains, when trapped from the mixer, 0.06 to 0.10 per cent V. According to Osann,[4] the oölitic ores at Harzburg contain 0.11 per cent V_2O_5, with an iron content of 29 per cent. Ledebur[5] found 0.072 per cent V, 0.056 per cent Ti, and 0.073 per cent Cr, in Thomas pig iron from Oberschlesien.

England. In 1864, E. Riley[6] discovered no less than 0.686 per cent V in pig iron produced from Wiltshire ores, an amount, however, that seems incredibly high, especially as the methods of analysis at that time were not reliable. J. E. Stead[7] claims the following contents of vanadium in pig iron from different English districts:

	Per Cent V		Per Cent V
Clarence	0.183	Holwell	0.186
Cleveland	0.262	Lincolnshire	0.168

These contents were also confirmed by analyses on English cast iron, lately made by me.

United States, Canada, and Norway. All iron ores mentioned above are high in phosphorus, and consequently suitable for Thomas and cast iron. In the United States, Canada, and Norway, on the contrary, iron ores containing vanadium are mostly magnetites, low in phosphorus and high in titanium. The greatest content of vanadium is to be found in titaniferous magnetites—that is, magnetites so high in titanium (> 2 to 3 per cent Ti) that they are used for making pig iron.

J. T. Singewald[8] has made a summary of the qualities of the American titaniferous magnetites, and their possibility of being worked. He gives the following analyses:

	Per Cent Fe	TiO_2	V_2O_5	P_2O_5
Iron Mine Hill, Rhode Island	33.0	10.0	0.22	0.02
Adirondack, N. Y., Split Rock mine	32.82	15.66	0.55	0.04
Adirondack, N. Y., Little Pond ore	41.57	18.82	0.62	Traces
	29.87	13.07	0.50	0.32
Adirondack N. Y., Tunnel Mountain	35.99	16.45	0.61	0.02
	24.65	10.55	0.34	0.46
Adirondack, N. Y., Sanford Hill [9]	47.47	21.02	0.35	n.d.
Tucker Lake, Minnesota	48.78	5.13	1.38	0.01

The largest deposits are Sanford Hill in the Adirondacks and at Iron Mountain in Wyoming. I have not been able to obtain any analysis from the Wyoming mine. The magnetites in New Jersey are mostly not so high in titanium as the ores mentioned above. They contain about 0.15 per cent V_2O_5, with about 65 per cent Fe, and about 1 per cent Ti. According to P. W. Shimer[10], pig iron produced from Virginia hematites and Lake Superior ore contains up to 0.02 per cent V, and pig iron from New Jersey magnetites 0.02 to 0.05 per cent V and 0.10 to 0.20 per cent Ti.

The Canadian titaniferous magnetites with vanadium

[4] Osann, *Eisenhüttenkunde,* I, p. 125.

[5] *Stahl und Eisen,* 1894, p. 813.

[6] *Journal Chem. Soc.,* XVII, p. 21.

[7] *Journal Ir. St. Inst.,* 1893: I, p. 170.

[8] Bureau of Mines, *Bulletin* No. 64.

[9] From C. J. Stark, *Iron Trade Review,* 1914: I, p. 721.

[10] *Trans.* Amer. Inst. Min. Eng., 1913: I, p. 467.

subject. In the final analysis each tentative installation would be an engineering problem in itself; the ultimate cost of moving the material by conveyor should be set against the cost of doing it by an alternative method, taking into account all of the physical conditions, the tonnage to be moved, and sundry other facts. In the absence of any appreciable volume of data from actual experience, many of the factors would have to be estimated. It seems reasonable, however, to predict that experiments under operating conditions will be made.

It is possible that more has been done in this direction than has come to my attention. There may be metal mines in the United States or elsewhere, in which serious attempts to use conveyors underground have proved failures; or there may even be instances where conveyors have been in successful use for a long time. If any one who has had experience in this connection cares to write concerning the conditions and the results, I shall be glad to see that his data, either with or without revealing his identity, get promptly to the industry.

Big Increase in Feldspar Production

Crude feldspar sold in the United States in 1924 amounted to 203,000 long tons, valued at $1,488,500, or $7.32 a ton, according to a statement prepared from reports received directly from producers and issued by the U. S. Geological Survey. These figures show an increase of 40 per cent in quantity and 41 per cent in value as compared with 1923. The greatest feldspar-producing region is in the Atlantic seaboard states from Maine to North Carolina. This region reported 95 per cent of the output for 1924. North Carolina, the leading state, reported about 47 per cent of the quantity sold; New Hampshire, the second, reported 19 per cent; and Maine, the third, 15 per cent. The average value per long ton in North Carolina was $6.46; in New Hampshire it was $8.22; and in Maine it was $9.07.

The production of crude feldspar by the leading states in 1924 is shown in the following table. The figures are subject to revision. The value is determined at the mine or the nearest shipping point.

Feldspar Production in 1924

State	Long Tons	Value	State	Long Tons	Value
California	8,000	$62,300	New York	13,800	$108,700
Connecticut	6,500	51,400	North Carolina	96,000	620,000
Maine	29,900	271,300	Pennsylvania	1,400	4,700
Maryland	4,800	25,000	Undistributed	3 600	21,100
New Hampshire	34,400	324,000	Total	203,400	$1,488,500

Except for a few minor purposes, feldspar is prepared for use by grinding. This work is done principally by commercial mills, but a very small proportion is ground by the users in their own mills. In 1924 there were thirty-two commercial mills in operation. These mills reported 189,780 short tons of ground feldspar sold in 1924, valued at $3,283,170, or $17.30 a ton. Of this quantity 163,905 tons, valued at $2,760,286, or $16.84 a ton, was domestic feldspar, and 25,875 tons, valued at $522,884, or $20.21 a ton, was Canadian feldspar.

Canadian feldspar was ground in two states—New York and Ohio. These figures represented small increases in quantity and value of both domestic and ground feldspar as compared with 1923.

Spanish Iron Mining Depressed

Great disappointment has been suffered by the iron-mining industry in the Bilbao district in Spain as a result of the gradual diminution in exportation during the first five months of the present year, says Commercial Attaché C. H. Cunningham in a report to the Department of Commerce from Madrid. This is especially notable, because the month of January began very favorably, and the prospects were so good that an increase of wages in the mines was agreed to for April 1, which has added considerably to the cost of production and has tied up the mine operators to a higher wage scale, operative throughout a period of three years.

Advance sales for the second half of the year are less than either those of the first half of the year or those of the second half of last year. Stocks on hand at the mine mouth as of May 1 were 585,000 tons, with prices for red ore at 13½ pesetas per ton, and for treated ore around 26. In March, 149,000 tons was exported to England, and 4,191 tons was consumed in Bilbao. Several mines have closed down, and others are offered for sale; still others find themselves very much embarrassed with new installations of modern equipment for the transportation and loading of their mine ore while they have to operate on a diminished production. It is reported that the Real Compania Asturiana is intending to extend its operations at Reocin, Province of Santander, where some new deposits of high-grade iron ore have been discovered.

During the month of May 14,000 tons of pyrites for France was exported from Sevilla, and 7,100 tons for England. At Cartagena a total of 32,800 tons was exported, and Baltimore is given as one of the ports of destination. Rumors have been rife in the Mining Department at Madrid that several inquiries for iron pyrites have been received from the United States recently and that four shipments have been made. The attaché has been unable to verify this statement.

The depression in the iron industries is said to be due to two causes, the first of which is the diminished activity of the British iron and steel trade, and the second, the gradual increase in exportation to England and France of Algerian iron ore at the expense of the Spanish. During the quarter January to March, inclusive, Spain's exportation to England diminished by 120,000 tons, while during the same period the movement of Algerian coal to the same market diminished only 22,000 tons.

During April the Penarroya mines exported 3,688 tons of lead ore to European destinations, and 489 tons of argentiferous lead to London. From the Penarroya mines near Cordova 3,400 bars of lead were sent to Bremen.

Mining Oil Sands

The Steaua Romana in Rumania is planning to obtain oil in Campina, where the field is becoming exhausted, by the shaft and gallery method as practiced at Pechelbronn, in Alsace, according to the *Oil News*, London. The carrying out of the operations is intrusted to a Belgian company, which has already begun work on a shaft on the Bucea property (eastern part of Campina). This method of winning oil is new in Rumania, although hand-dug wells are quite common and have been put down more than 600 ft.

and this tendency is still more distinct at Grängesberg, where the low-phosphorus ores, according to Enlund's analyses, contain little vanadium. Judged from the analyses mentioned above, it also seems as if the C and D qualities from these deposits frequently were highest in vanadium. Gellivara and Tuollavara ores contain less vanadium than the other ores, and of these, Kiruna more than Grängesberg and Blötberget. For Kiruna it may be calculated at 0.18 to 0.20 per cent, for Grängesberg and Blötbergot, at 0.15 to 0.17 per cent.

II. The Conduct of Vanadium in the Furnace Processes

Few facts have been given in the literature on the behavior of vanadium in the furnace processes, and consequently it may be desirable to consider this question. The investigations mentioned above made by L. Blum[2] at Esch in the "minette" district, show the circumstances in the Thomas practice. The blast-furnace charge on that occasion contained only "minettes" with the iron and vanadium contents given on page 51, and Poti ore (manganese ore from the Caucasus). No vanadium was present in the Poti ore, the coke, or the lime for the Thomas mill, and consequently it could come only from the "minettes." The approximate percentage composition of the Thomas pig iron was as follows: Si, 0.4; Mn, 1.2; P, 1.8; and S, 0.06. The vanadium content in the pig iron was somewhat variable:

Tap	Per Cent V in Pig Iron	Per Cent V in Blast-Furnace Slag	Vanadium in the Pig Iron as per Cent of the Amount Charged
I	0.203	0.139	57
II	0.203	0.144	56
III	0.155	0.105	57
IV	0.163	0.107	58
V	.....	0.109	..
VI	.....	0.120	..
Average	0.181	0.121	57

It was calculated, on a quantity of 110 lb. of slag per 100 lb. of pig iron, to get the distribution of vanadium in the pig iron and slag. As a result of the great quantity of slag, only about 60 per cent of the vanadium was to be found in the pig iron. The ladle slag contained 2.11 per cent V_2O_5, and the mixer slag 0.65 to 0.90 per cent, consequently 13 per cent of the vanadium was slagged off in the ladle and the mixer. Practically all of the vanadium was slagged off in the Thomas converter, and the average vanadium content in Thomas steel was only 0.010 per cent. The Thomas slag contained 1.24 to 1.55 per cent V_2O_5.

P. W. Shimer[16] says that vanadium and titanium behave like silicon in the blast furnace. He gives the following analyses, all on the same charge:

Tap	Per Cent V	Per Cent Si	Per Cent S
I	0.042	3.46	0.022
II	0.038	2.26	0.041
III	0.029	0.52	0.106

When the pig iron was remelted in a cupola furnace, 15 per cent of the vanadium was slagged off.

An extensive investigation on melting titaniferous magnetites containing vanadium was made by C. J. Stark in an American blast furnace, but the reports are incomplete and no inferences concerning the reduction of vanadium can be drawn.

J. A. Leffler[17] gives some interesting facts on the behavior of vanadium and titanium in electric shaft furnaces in the experimental plant at Trollhättan in Sweden. Two charges containing vanadium were smelted—No. 78, consisting of Kiruna A ore only (69.5 per cent Fe, 0.30 to 0.40 per cent TiO_2, and 0.16 to 0.18 per cent V_2O_5), and No. 79, with 50 per cent of the same ore and 50 per cent magnetite without vanadium. The quantity of slag to each 100 lb. of pig iron was 12.5 and 39.3 lb. respectively. Table II clearly shows the smelting results.

Table II

Charge No.	78			79
Tap No.	1,575	1,580	1,595	1,664
Pig Iron:	Per Cent			
C	4.20	3.72	4.20	3.12
Si	0.94	0.14	0.27	0.42
Mn	0.21	0.15	0.20	0.33
Ti	0.25	0.04	0.14	0.02
V	0.11	0.06	0.11	0.06
Ni	0.07	0.07	0.08	0.03
Cu	0.003	0.003	0.004	0.005
S	0.004	0.014	0.003	0.009
P	0.039	0.040	0.044	0.027
Slag:				
SiO_2	39.39	35.97	33.65	42.26
Al_2O_3	15.44	12.09	11.28	3.80
TiO_2	2.48	3.67	3.33	0.88
V_2O_5	0.00	0.12	0.05	0.05
FeO	0.60	1.43	1.48	2.19
MnO	0.34	0.57	0.43	1.30
CaO	30.99	38.53	40.40	41.02
MgO	10.11	7.46	9.22	8.73
P_2O_5	0.015	0.026	0.034	0.021
S	0.10	0.065	0.11	0.024
NiO	0.00	0.00	0.00	0.00
Total	99.465	99.931	99.984	100.275

The distribution of vanadium and titanium is shown in the following table:

	Taps 1,575	1,580	1,595	1,664
	Per Cent			
Vanadium in pig iron	100	88	97	85
Vanadium in slag	0	12	3	15
Titanium in pig iron	57	13	36	9
Titanium in slag	43	87	64	91

It is evident from this how much easier it is to reduce vanadium than titanium, and even when the furnace works cold vanadium joins the pig iron almost completely, whereas the reduction of titanium varies with the working of the furnace.

When reducing Norwegian magnetites in an electric arc furnace, B. de Alzugaray[18] got the following pig iron, which was then decarburized in a basic open-hearth furnace:

	Per Cent Pig Iron	Per Cent Steel
C	3.28	0.18
Si	2.60	0.10
Mn	0.60	0.70
Ti	3.03	0.12
V	0.35	0.23

As silicon and titanium have a higher affinity for oxygen than has vanadium, the latter will be protected from oxidation by them.

Ledebur[5] also studied the behavior of vanadium during decarburization of Thomas pig iron, and gives the following analysis:

	Per Cent Pig Iron	Per Cent Thomas Steel
V	0.072	0.001
Ti	0.056	n.d.
Cr	0.073	0.013

Here the vanadium is completely oxidized.

Original Investigations

I have studied the behavior of vanadium during an extensive examination of the bessemer and Thomas processes. A complete account of material and heat balances, measurement of temperatures, composition of gases, etc., was published in *Järnkontorets Annaler*, 1924, No. 1. I will here give only a short epitome of the article, with further facts concerning blast-furnace practice and experimental heats not before mentioned.

[17] *Järnkontorets Annaler*, 1913, p. 21.

[18] *Journal Ir. St. Inst.*, 1915: I, p. 550.

were investigated by F. Pope[11] with the following results:

	Per Cent			
	Fe	TiO_2	V_2O_5	P_2O_5
Chaffey mine	49.90	10.21	0.35	0.07
Pine Lake ore	44.40	13.52	0.52	0.02
Eagle Lake mine	64.60	6.41	0.23	0.03
Millbridge	48.55	8.17	0.29	0.09
Horton	43.80	17.23	0.63	0.14

In magnetites without titanium only traces of vanadium could be found. The magnetite sand with titanium, found in heavy beds in Canada, also contains vanadium, but no analyses are available.

In Norway are large deposits of titaniferous magnetites, among which especially those at Ekersund-Soggendal in the southwestern part of the country are noticed. Also, these ores contain vanadium, but I have been unable to find any reliable analyses.

Sweden. The Swedish iron ores have been more carefully investigated as to their vanadium content than those of any other country. Vanadium is found in all titaniferous magnetites as well as in the magnetites rich in phosphorus, and also in those ores poor in phosphorus which accompany the last mentioned. I shall now first give an account of the titaniferous magnetites not yet used, and then of the used iron ores, poor in titanium.

1. Among the *titaniferous magnetites* the following are especially important:

	Per Cent			
	Fe	TiO_2	V_2O_5	P_2O_5
Taberg ore[12]	37.72	7.50	0.23	0.009
Taberg concentrates[12]	49.85	10.40	0.64	0.014
Taberg waste products[12]	27.33	3.30	0.13	0.009
Taberg rich lump ore[13]	41.0	17.00	0.62	n.d.
Taberg concentrate of rich lump ore[13]	53.8	16.50	1.15	n.d.
Ruotivare ore[14]	52.11	11.10	0.26	0.013
Ruotivare concentrates[14]	58.80	8.38	0.32	0.009
Kramsta ore[15]	23.8	5.0	0.40	n.d.
Kramsta concentrates[15]	60-65	ca 5.5	ca 1.40	0.007

The possibilities of these large deposits being worked for vanadium will be discussed later.

2. *Ores Poor in Titanium.* In the high-quality ores with little or no phosphorus or titanium, vanadium has not been found. On the contrary, the ores from Grängesberg, Blötberget, Kiruna, Gellivara, Tuolluvara, and other deposits high or low in phosphorus contain considerable contents of vanadium (see Table I).

Besides the analyses given in Table I, I have received the following analyses from the Trafikaktiebolaget Grängesberg - Oxelösund, all obtained from general samples:

	Per Cent V_2O_5
Kiruna A ore (P< 0.040 per cent)	0.15
B ore (P= 0.040 to 0.10 per cent)	0.15
C ore (P=0.10 to 0.60 per cent)	0.15 to 0.18
G ore (P> 2.0 per cent)	0.09
Luossavara A ore	0.22
B ore	0.20
C ore	0.17
Gellivara A concentrate	0.14

B. D. Enlund[16] gives the following contents of vanadium in Grängesberg ores:

	Per Cent	
	V_2O_5	TiO_2
Exportfield, magnetite	0.24	0.13
Exportfield, hematite	0.22	0.185
Exportfield, ore, low in phosphorus	0.05	n.d.
Timmer mine	0.22	n.d.
Karl mine, apatite ore	0.21	n.d.
Exportfield, apatite ore (5 per cent P)	0.11	0.15
Exportfield, apatite ore (9 per cent P)	0.07	0.22

Some of these contents seem to be very high. Enlund may have made some error in the analysis.

The Tuollavara ore contains a little less vanadium, for instance:

	Per Cent	
	V_2O_5	TiO_2
Tuollavara A ore	0.08	0.65
Tuollavara B ore	0.04	0.70

From this summary it is evident that iron ores with vanadium always contain titanium or phosphorus. It might be inferred that vanadic acid is present in the same minerals as titanic and phosphorus acid and partly replaces these substances. However, many facts indicate that this is not so, but that the vanadic acid is present in the iron mineral itself, apparently replacing a part of the iron oxide in the magnetite. On dressing titaniferous magnetites, as well as ores high in phosphorus, the vanadium remains with the iron (cf. the separation of the Kramsta ore in the column adjoining this). The vanadium and iron contents rise or fall together in analyses from different parts of the titaniferous magnetite deposits at Kramsta.

The variation of the vanadium content in the Grängesberg and Kiruna ores is not so regular. Anyhow, the apatite ores from these deposits show a low vanadium content. I could find nothing but traces of vanadium in apatite ore from Grängesberg (see Table I); Enlund gives somewhat higher contents. Kiruna A ore (low in phosphorus) shows a tendency toward lower vanadium than the other ores from this deposit,

[11] *Trans.* Amer. Inst. Min. Eng., 1899, p. 372.
[12] From E. Odelstierna, Wärmländska Bergsmannaföreningens Annaler, 1910, p. 42.
[13] Analyzed by the author.
[14] From F. R. Tegengren, Sveriges Geologiska Undersökning, 1910, No. 2, p. 25.
[15] According to a private report.
[16] Wärmländska Bergsmannaföreningens Annaler, 1915, p. 106.

Table I—Analyses of Various Swedish Ores

Ore	Fe_2O_3	FeO	MnO	CaO	MgO	Al_2O_3	SiO_2	TiO_2	P_2O_5	V_2O_5	S	Total	Fe	P	V	Ni
Kiruna:																
General analysis 1912, A ore[1]	66.43	29.57	0.21	0.37	0.61	0.21	1.84	0.30	0.048	0.16	0.023	99.81	69.5	0.021	0.09	0.04
General analysis 1912, C ore[1]	68.43	25.71	0.17	0.93	0.98	0.30	2.02	0.62	0.36	0.20	0.004	99.77	67.9	0.16	0.11	0.05
General analysis 1912, D ore[1]	71.14	18.51	0.15	5.00	0.24	0.13	0.40	0.04	3.84	0.20	0.018	99.70	64.2	1.67	0.11	0.04
General analysis 1912, G ore[1]	57.43	22.37	0.19	9.10	0.38	0.23	1.54	0.02	6.99	0.15	0.018	98.44	57.6	3.05	0.08	0.03
Diamond drill hole, Zenobia II, A ore[2]	65.86	29.57	0.15	0.55	0.98	0.20	1.88	0.10	0.014	0.19	0.27	99.76	69.1	0.006	0.11	trace
Diamond drill hole, Max, A ore[2]	64.43	29.31	0.22	0.63	1.34	0.17	3.02	0.72	0.005	0.13	0.11	100.14	67.9	0.002	0.07	0.05
Diamond drill hole, Hjalmar II, A ore[2]	67.00	28.56	0.19	0.59	1.08	0.20	1.76	0.24	0.025	0.20	0.11	100.00	69.1	0.011	0.11	0.04
Diamond drill hole, John II, A ore[2]	62.57	27.00	0.23	1.85	1.92	0.16	4.98	0.51	0.011	0.17	0.036	99.49	64.8	0.005	0.10	0.05
Diamond drill hole, Kunigunda II, A ore[2]	65.71	30.21	0.26	0.52	0.94	0.22	1.44	0.14	0.013	0.17	0.009	99.63	69.5	0.006	0.10	trace
Mertainen:																
A concentrate[1]	64.1	26.2	0.19	0.4	0.4	1.6	6.0	0.2	0.016	0.15	0.005	99.26	65.3	0.007	0.008	n.d.
Grängesberg:																
General analysis 1923, lump ore[3]	62.03	21.55	0.19	3.64	1.99	1.24	6.15	0.13	2.20	0.16	0.011	99.29	60.2	0.96	0.09	n.d.
General analysis 1923, fine ore[3]	67.41	20.22	0.14	2.95	1.47	1.03	4.21	0.12	1.76	0.16	0.011	99.48	62.9	0.77	0.09	n.d.
Apatite ore	20.00	8.20	0.32	27.30	2.20	1.25	14.00	CaF_2 6.20	19.80	trace	0.020	99.29	20.5	8.50	trace	n.d.
Blöberget:																
Kalfgruve magnetite[4]	54.74	26.47	0.17	2.72	2.53	1.09	10.19	n.d.	1.45	0.15	0.007	99.52	58.9	0.63	0.08	n.d.
Magnetite concentrate[4]	65.10	30.28	0.14	0.62	0.71	0.29	2.60	n.d.	0.25	0.21	0.010	100.21	69.0	0.11	0.12	n.d.
Flygruve hematite, lump ore[4]	83.52	4.81	0.18	2.31	0.58	0.72	5.72	n.d.	2.15	0.12	0.010	100.12	62.2	0.94	0.07	n.d.
Flygruve hematite, fine ore[4]	86.11	4.60	0.20	2.30	0.53	0.56	4.25	n.d.	1.60	0.12	0.010	100.28	63.5	0.70	0.07	n.d.

[1] From *Järnkontorets Annaler*, 1923, Tekniska Diskussionsmotet, p. 42-43.
[2] From *Järnkontorets Annaler*, 1924, p. 236.
[3] Reported by the Trafikaktiebolaget Grängesburg-Oxelösund.
[4] Reported by the Bergsverksaktiebolaget Vulcanus, Blötberget.

Table III

	Thomas Heat Nos. C 36	C 47	C 66	C 73
	Per Cent			
Pig Iron:				
C	2.82	2.93	2.94	2.80
Si	0.16	0.19	0.13	0.10
Mn	1.13	1.17	1.00	0.89
P	2.04	2.04	2.08	2.06
S	0.054	0.057	0.054	0.050
V	0.21	0.18	0.21	0.22
Ti	0.02	n.d.	0.02	0.02
Blast-Furnace Slag:				
SiO_2	30.25	30.62	31.03	30.24
Al_2O_3	9.20	9.50	8.00	8.56
TiO_2	0.58	0.58	0.65	0.58
FeO	0.67	0.35	0.99	0.58
MnO	0.88	1.00	1.53	1.14
CaO	45.50	46.50	45.20	46.75
MgO	7.02	6.51	6.52	6.00
P_2O_5	0.55	0.26	0.75	0.51
V_2O_5	0.06	trace	0.10	trace
S	0.75	0.77	0.69	0.72
Total (alkalis not determined)	95.46	96.09	95.46	95.08

Steel Works C. In the first experiments the blast-furnace charge consisted of Grängesberg ore, Thomas slag, limestone, and a manganese ore. About half of the slag from the Thomas mill was used in the blast furnace, which about doubled the vanadium content in the pig iron. The fuel consisted of coke and charcoal in equal volume, the quantity of slag per 100 lb. of pig iron was about 49 lb., the temperature of the blast 850 deg. F., and the air pressure 4.6 to 6 in. of mercury. The pig iron was blown at once, and no mixer was used. Table III shows the composition of the pig iron and the blast-furnace slag.

The vanadium was divided between the pig iron and slag as follows:

Heat No.	C 36	C 47	C 66	C 73
	Per Cent			
Pig iron	93	100	89	100
Slag	7	0	11	0

The FeO, MnO, P_2O_5, and V_2O_5 contents varied with the working of the blast furnace.

The course of the Thomas process was investigated during heats C 36, 66, and 73 by tilting the converter and taking samples. Among others the results shown in Table IV were obtained.

Besides may be given:

Heat No.	C 36	C 66	C 73
		Per Cent	
P_2O_5 in the final slag	n.d.	21.25	20.05
V_2O_5 in the final slag	n.d.	1.96	1.94
Temperature of pig iron when poured into the converter, deg. F.	2,280	2,360	2,235 (cold)
Net time of blowing (11,000 lb. charge)	12 min. 20 sec.	11 min. 20 sec.	13 min. 35 sec.

To study the increase in temperature during the first minutes of blowing, and thereby also the possibility of moving the steel into another converter which is included in my duplex process for extracting vanadium, two experimental heats were later blown at Steel Works C.

Heat C 88. Before the blast no lime or scrap was charged. The blowing was interrupted 2½ minutes after the start, and after having taken a sample of the melt some steel was poured out of the converter to get a clear stream for observation with the optical pyrometer. The temperature of the pig iron when poured into the converter was 2,210 deg. F., and 2½ minutes after the start of blowing, 2,410 deg. F. The composition of the metal was changed as follows:

	C	Si	Mn	P	V
	Per Cent				
Pig iron	3.39	0.61	0.10	2.11	0.13
2½ minutes after starting	2.92	0.10	....	2.10	0.03

The slag contained 36.60 per cent SiO_2, 4.15 MnO, 29.50 FeO, and 4.70 per cent V_2O_5.

Heat C 99. This heat was worked in a similar way. Two and one-half minutes after starting, about one-third of the melt was poured into a ladle, left there 10 to 15 minutes, and then poured into the converter again. The steel was now very fluid, and very little residue was left in the ladle. The temperature of the pig iron when poured into the converter was 2,240 deg. F.; of the metal 2½ minutes after the start, 2,420 deg.; and when poured back into the ladle, 2,310 deg.

Analysis of the metal:

	C	Si	Mn	P	V
	Per Cent				
Pig iron	3.50	0.47	0.10	2.20	0.12
2½ minutes after starting	2.94	0.07	....	2.21	0.02

The slag contained 32.25 per cent SiO_2, 4.50 MnO, 25.75 FeO, and 5.80 per cent V_2O_5. The vanadium content in the pig iron was lower in the last two heats than in those earlier mentioned because no Thomas slag was charged in the blast furnace. Consequently, the vanadium comes from the Grängesberg ore only.

Steel Works D. In the Thomas mill, two heats, D 600 and 602, were investigated (Table V):

	Heat No. D 600	D 602
Temperature of pig iron when poured into the converter, deg. F.	2,200	2,200
Net time of blowing (48,400 lb. charge)	15 min. 35 sec.	15 min. 30 sec

Table V

Sample	Time After Start of Blowing	Composition of the Metal, Per Cent C	Si	Mn	P	V	Ti
D 600							
Pig iron	.....	2.80	0.49	1.45	3.16	0.06	0.03
I	3 min. 10 sec.	2.45	0.045	0.60	3.19	0.04	0.0
II	6 min. 20 sec.	1.85	0.030	0.40	2.72	0.0	0.0
D 602							
Pig iron	.....	2.92	0.48	1.36	3.26	0.07	0.03
I	3 min. 0 sec.	2.40	0.012	0.69	3.22	0.04	0.0
II	6 min. 10 sec.	1.98	0.017	0.47	2.75	0.0	0.0

Summary of Investigations

Vanadium is easily reduced in the blast furnace, and when the furnace works cold most of the vanadium will be found in the pig iron. With hot working of the furnace and small quantities of slag, it will be practically completely reduced, but the greater the quantity of slag the greater the quantity of vanadium it will

Table IV

Sample	Time After Start of Blowing	Metal C	Si	Mn	P	V	Ti	Slag FeO	MnO	P_2O_5	V_2O_5
	C 36										
Pig iron	.....	2.82	0.16	1.13	2.04	0.21	0.02	.....	.....	.....	....
I	2 min. 30 sec.	2.46	0.008	0.10	1.90	0.01	0.0	.....	.....	.....	....
II	5 min. 05 sec.	1.47	0.009	0.15	1.87	0.0	0.0	.....	.....	.....	....
	C 66										
Pig iron	.....	2.94	0.13	1.00	2.08	0.21	0.02	.....	.....	.....	....
I	2 min. 40 sec.	2.39	0.014	0.04	1.77	0.01	0.0	10.10	18.83	12.88	6.20
II	5 min. 10 sec.	1.36	0.010	0.07	1.66	0.0	0.0	9.49	15.36	15.64	5.33
	C 73										
Pig iron	.....	2.80	0.10	0.89	2.06	0.22	0.02	.....	.....	.....	....
I	2 min. 35 sec.	2.56	0.012	0.28	2.08	0.08	0.0	.....	.....	.....	....
II	4 min. 55 sec.	2.03	0.011	0.14	1.80	0.01	0.0	11.90	14.75	11.25	5.52
III	6 min. 55 sec.	0.92	0.009	0.20	1.76	0.0	0.0	9.41	13.11	12.08	5.36

take from the ore. The reduction of vanadium is facilitated by a basic blast-furnace slag, because the reduction of vanadic acid goes via lower oxides, all being of a basic nature. The reduction conditions are very favorable when Thomas pig iron is manufactured.

When refining pig iron, vanadium will be slagged quickly and completely if the pig iron is not high in silicon and titanium, these substances having a higher affinity for oxygen than has vanadium. If the temperature of the pig iron is low in a Thomas heat, the oxidation of vanadium will be delayed. A decarburized steel retains little of the vanadium content of the pig iron.

III. Methods Hitherto Suggested for Extracting Vanadium From Iron Ores

When a metal is to be extracted from an ore by a chemical or metallurgical process, it is, of course, necessary for economical manufacture that the ore be not too low in the metal sought. It was mentioned in the first part of this article how the extraction of vanadium from Thomas slag at Le Creusot was stopped when rich vanadium ores were discovered. The vanadium content of the slag was too low compared with the ores, and this is generally true of the slags of iron ores containing vanadium. For an economical extraction of vanadium from iron ores it is necessary that the vanadium should be concentrated in a product that with regard to the vanadium content is not inferior to natural vanadium ores, and the expense for manufacturing this concentrate must not exceed the price of natural ores. Consequently it is a problem of concentration, that is to be solved in a mechanical or metallurgical way, or both.

Among the vanadium-containing iron ores the titaniferous magnetites have hitherto been most noticed, because of their relatively high vanadium content. Besides, their low iron content generally enables the production of a still richer concentrate, by magnetic separation, as vanadium remains with the magnetite in this process. The titanic acid is present principally as ilmenite, which is weakly magnetic compared with the magnetite. However, the magnetic separation gives varying results for different ores, owing to *how* the ilmenite is present. It may be found as crystals of about the same size as the magnetite, or be more or less finely disseminated in the magnetite crystals. It may be so fine that it has not heretofore been possible to observe the separate ilmenite crystals with the microscope, so it was believed that the titanic acid and the magnetite formed a special mineral. When the ilmenite crystals are so small, it is impossible to separate the titanic acid, even after the finest crushing.

The American titaniferous magnetites[3] from Sanford Hill and Iron Mountain as well as the Norwegian[19] from Ekersund-Soggendal are generally easily separated and give concentrates low in titanium. No facts, however, are given as to the behavior of vanadium. The ore from Taberg in Sweden is known to be difficult to dress, and its vanadium content is not high enough to allow an economical extraction of vanadium under normal conditions.

The only Swedish titaniferous magnetite that at present seems possible to be worked for vanadium is the ore from Kramsta, in the province of Hälsingland. It contains on an average 23.8 per cent Fe, 5.0 TiO_2, and 0.40 per cent V_2O_5. B. Kjellberg[20] obtained a concentrate with 60 to 66 per cent Fe, 5 to 6 per cent TiO_2, and about 1.40 per cent V_2O_5. One concentrate had the following composition:

	Per Cent			Per Cent	
SiO_2	4.38		CaO	1.66	
TiO_2	5.16	(Ti=3.10)	MgO	2.18	
V_2O_5	1.35	(V=0.76)	Loss on ignition	0.18	
Al_2O_3	0.31		P_2O_5	0.007	(P=0.003)
Fe_2O_3	49.14	(Fe=60.8)	S	1.38	
FeO	33.94				
MnO	0.30	(Mn=0.23)	Total	100.007	

The yield was only 20 per cent, consequently 50 per cent of the iron, 80 per cent of the titanium, and 30 per cent of the vanadium was lost in the waste products.

A chemical lixiviation process having proved to be uneconomical, Kjellberg suggested a metallurgical separation process for extracting vanadium from this concentrate. According to this method, the concentrate was to be reduced in an electric arc furnace, and the iron obtained as pig iron free from vanadium, while the vanadium was to be concentrated in the slag. As given, the method cannot be used, for the vanadium is apt to join the pig iron. On the contrary, the desired result could be obtained if the furnace were worked on decarburized steel instead of on pig iron. Vanadium was to be extracted from the slag in the same way as from vanadium ores.

W. L. Goodwin and W. P. Firth have obtained a patent for a process of extracting vanadium from iron ores (titaniferous magnetites) as follows: The slag obtained by decarburization of pig iron containing vanadium, which takes all the vanadium from the pig iron, will be remelted again in a furnace with more ore, and in that way a pig iron still richer in vanadium will be produced. This pig iron is to be refined and the process repeated until the pig iron holds so much vanadium that it can be used in the manufacture of vanadium steel. The use of such a vanadium alloy of course is limited.

IV. A New Method for Extracting Vanadium

The method that I have devised for extracting vanadium from iron ores is put forward with attention to the observation on the behavior of vanadium in the furnace processes mentioned above, and is founded on the following two principles:

1. The vanadium enters the pig iron almost completely upon the reduction of the ore in the blast furnace.

2. The vanadium will be slagged off quickly during the refining of the pig iron, and during the first moment of the process a slag of a very high vanadium content will be formed. This slag is now to be separated from the metal, which is to be refined completely in the ordinary way.

By this process the vanadium content of the iron ore will be concentrated about fifty times, and the vanadium will be obtained as a slag, high in vanadium. This slag may then be worked in the same way as the natural vanadium ores. At first I proposed that the method be used in the Thomas practice, the metallurgical conditions there being most favorable, and ores for Thomas pig iron containing the greatest quantities of vanadium. Consequently the refining of Thomas pig iron will be performed in two stages:

[19] J. H. L. Vogt, Norges Jernmalmforekomster.

[20] *Järnkontorets Annaler*, 1921, p. 147.

1. The pig iron is refined for 3 or 4 minutes, according to experience, in an acid converter until the vanadium passes into the slag. At the same time silicon and titanium, most of the manganese, and some carbon, but little or no phosphorus, will be slagged off. The metal is now to be poured into the pig-iron ladle, the vanadium slag being kept back and then poured into a box. If any slag should enter the ladle, it ought to be skimmed off.

2. The metal is poured into a basic converter, and completely refined in the ordinary way.

The two parts of the process may preferably be worked in different converters, partly to enable the gathering of the vanadium slag completely, and partly to prevent its being diluted with the Thomas slag left in the converter at the end of each heat. Besides, the first converter is equipped with an acid lining to avoid oxidation of the phosphorus, as it is troublesome to separate phosphorus from vanadium in the further manufacturing of ferrovanadium from the slag. The pig iron must be hot and low in silicon in order that the oxidation of vanadium be not delayed. On the contrary, manganese will have no influence on account of its having less affinity for oxygen than vanadium, and, anyhow, either iron or manganese must be slagged to form bases in the slag. The phosphorus content is to be kept proportionately high. The vanadium slag will contain at least 10 per cent vanadium oxide if the vanadium content in the pig iron be about 0.20 per cent, and further silica, ferrous oxide, and manganese oxide, as well as substances from the acid lining. For the manufacturing of ferrovanadium the slag may be submitted to chloridizing roasting and the vanadium then dissolved out as vanadate of sodium. From this solution, vanadate of iron may be precipitated with sulphate of iron, and the vanadate afterward reduced with aluminum or silicon, or in some other way. The residue from the lixiviation of vanadium may then be charged in the blast furnace or mixed with the charge in the basic converter.

According to the investigations of Blum (see pages 51 and 53), a content of about 0.15 to 0.20 per cent vanadium might be expected in a pig iron produced from "minettes." However, it is not asserted that all "minettes" are so high in vanadium as those mentioned by Blum. A blast-furnace charge of mixed "minettes" and Swedish ores high in phosphorus will give about 0.15 to 0.20 per cent vanadium. If the ores are too low in phosphorus and it becomes necessary to add phosphorus in the blast furnace, the amount of vanadium in the pig iron can be heightened by charging Thomas slag containing vanadium (see page 54). If, for instance, one-third of the annual output of slag can be used for this purpose, the duplex process is required for only two-thirds of the pig iron production in order to extract completely the vanadium from the ores.

A pig iron still higher in vanadium can be produced from a mixed charge of Swedish ore and Kramsta concentrate. Seventy per cent Kiruna D, plus 30 per cent Kramsta, for instance, ought to give a Thomas pig iron with 0.40 per cent vanadium. It must, however, be observed that the blast-furnace slag will be high in titanium oxide—in this case about 10 to 12 per cent. In electric shaft furnaces in Sweden, however, slags with 7 per cent titanium oxide are produced without any trouble, and still higher contents have several times been mentioned in the literature.

The economical prospects for this method will also be mentioned briefly. The only increase in expense attached to the process compared with the ordinary Thomas process are those incident to another converter with its consequent labor costs. These expenses should not be higher than 3s. per ton of pig iron. The output of vanadium per ton of pig iron is about 3.3 lb. V = 5.9 lb. V_2O_5, and the expenses for making the vanadium slag will consequently be about 6d. per pound of V_2O_5. The market price of vanadium ore is 4s. 1d. per pound of contained V_2O_5. As to the slag, it may be calculated at 3s. 6d., and consequently a profit of about 3s. per pound of V_2O_5, about 18s. per ton of pig iron, may be realized. With the present prices, the profit would be very high, but it is to be expected that the vanadium price will fall with an increased production. An annual output of 1,000,000 tons of pig iron corresponds to about 1,500 tons of vanadium, whereas the present output amounts to about 600 to 800 tons.

Distillation of Quicksilver at the Patriquin Mine, in California

The Patriquin quicksilver mine has been the principal quicksilver producer in Monterey County, Calif. The Paloma Mining Co. took over the property on Aug. 16, 1924, according to the California State Mining Bureau, from whose bulletin, "Mining in California," the following data are abstracted.

Extensive improvements in the reduction equipment and surface plant have been made, a new 60-ton Gould rotary furnace and condensing system being the principal addition. The crushing plant has been reconstructed and an automatic Challenge feeder added.

Ore from the three tunnel levels is trammed direct to bins above the furnace and dumped on a grizzly, the oversize being broken in a Dodge jaw crusher. It is drawn from the bins by a Challenge feeder, which discharges to a screw feeder 10 ft. long, extending through the dust chamber. The screw feeder is driven at 135 r.p.m. The dust chamber is of brick and concrete construction with compression joint between it and the rotary kiln. The rotary furnace is 40 ft. in length by 3 ft. diameter and is geared to make one complete revolution per minute. It is of the tire-type, resting on roller bearings, and is lined with firebrick. A 15-hp. Fairbanks-Morse gas engine drives all the machinery except the ore-bin crusher, which has a separate drive. Fuel oil is hauled in a tank by truck from Coalinga and delivered to three 200-bbl. storage tanks. A Witt oil burner is used and a 40-cu.ft. capacity compressor supplies air at 50 lb. pressure for the burner. There is a concrete draw pit underneath the discharge end of the furnace of 3 tons' capacity for the burned rock. A wooden pipe leads down from the top of the dust chamber to the concrete condensing chambers. In this connecting pipe are four water sprays, this being the only point at which water sprays are used.

The condenser system comprises a concrete base and wooden top section connected by eight vitrified pipes set at an angle of about 45 deg. The fumes pass up the first pipe, down the second, up the third, down the fourth, etc., finally down the last one, then back under the set and through a further section of pipe resting at an angle of about 30 deg. to a second concrete chamber and then through approximately 100 ft. of pipe resting at an angle of about 30 deg. to the stack.

A Journey to South Africa—II

From Cape Town to Johannesburg

By T. A. Rickard

ELISABETHVILLE, Belgian Congo, May 9—The spirit of Rhodes broods over South Africa, and the evidence of his work is to be seen on every hand. On landing at Cape Town the traveler is greeted by the statue of Van Riebeek, which stands on the quay to remind him of the founder of the colony. It was Rhodes who placed the statue there in compliment to the Dutch, with whom he tried to co-operate loyally, until he made the fatal blunder of the Jameson raid in 1895, and thereby sowed the seeds of a new antagonism between the British and the Dutch.

My readers will recall the fact that the first European to land in South Africa was a Portuguese navigator, Bartolomeu Dias, in 1487. The first settlement was established by Van Riebeek, on behalf of the Dutch East India Co., in 1652. It was not until 1814 that the British obtained final possession of the Cape Colony. The slaves were emancipated in 1833, and the inequitable adjustment of their property rights in slaves was one of the reasons that led the Dutch, or Boers, to migrate in 1836 across the Vaal river into the country now known as the Transvaal. The first Boer war was fought in 1881, and the second in 1899. During the World War the Dutch and British fought together against the Germans, one consequence being the conquest of German Southwest Africa; which is now a part (under a mandate) of the Union of South Africa.

Reminders of Cecil Rhodes

In leaving Cape Town, as in arriving, one is reminded of Rhodes, for, as the train goes northward, one sees the back of Table Mountain, which he adorned with trees, and the park of Groote Schuur, which, with its house, he bequeathed as a residence for the Premiers of the Union. The railroad crosses a sandy flat, connecting the peninsula of the Cape with the mainland. I do not remember having seen any statement of the obvious fact that the Cape peninsula must have been an island at a date geologically recent, because only a stretch of sand separates the Atlantic and the Indian oceans at its northern extremity.

We were glad to leave Cape Town, for we happened to be there during a hot period, 101 deg. F. in the shade, plus humidity. The train left at 4 p.m., and we arrived at Kimberley next day at 7:12 p.m. The distance is 650 miles, and the gain in elevation is 4,500 ft. The journey takes one at first through a most pleasing country, especially at Paarl and Wellington, where many attractive farms are to be seen. It became cool as we gained elevation and the purple shadows of the western range advanced slowly up the glowing face of the eastern hills. In the morning, we were on the uplands of the Karroo, a semi-arid region, but now freshly green, thanks to the recent rains. From the car-window we saw ostriches and antelopes. Herds of donkeys, sheep, and goats were enjoying the fresh pasture. Stretches of plain, showing cactus and scrub, were reminiscent of Arizona and New Mexico, but the well-kept ranch-houses and the clumps of acacia trees made a difference. The landscape was marked by many curiously shaped hills—spionkops, spitzkops, and table mountains—originating from the variant erosion of quartzite strata lying upon the basal granite. Native children came to beg for a "tickey"—the three-penny piece; they showed the spotty hair of the Bushman race, and looked miserable.

An occasional block-house reminded us of the Boer war; we saw, also, the military cemeteries—small, I am glad to add—and the remains of old trenches. The block-houses are kept in repair where the railroad crosses the streams over steel bridges. The road-bed

The big pit of the Kimberley mine

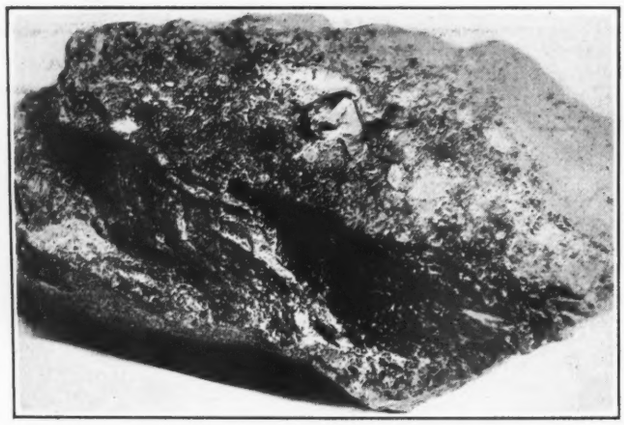
is well ballasted, and the traveling comfortable, in compartment cars admirably suited to the purpose. A towel, bedding, and the making of the bed by the attendant cost only 75c. per day. For $2 we obtained our three meals per day. The food was excellent, and we had a choice of wines, African or French, sufficient to gladden any American of good taste! South of the Orange River we crossed a fine grassy prairie—the veld (pronounced feldt) at its best. A herd of antelope, jumping gaily, gave local color to the scene.

On arrival at Kimberley, we were taken by Colonel Ralph Stokes to the Belgrave Hotel. This is run by the De Beers Consolidated Co. for the benefit of directors, guests, and visitors. It is like a first-class country club, and leaves nothing to be desired. Again we were reminded of the part played by Rhodes in the history of South Africa. A monument to him, given by his

friend Alfred Beit, stands in the middle of Kimberley. On the outskirts are the house and playground of Alexandersfontein, established by Rhodes for the people of the town. Everywhere are the avenues of trees he planted, now a charming feature of the "diamond city."

In 1867 a child was playing with a pebble on the bank of the Orange River when a visitor, a Dutch farmer, noticed its brilliance. The mother of the child gave the stone to him, and he, in turn, showed it to a trader, who sent it to a mineralogist at the Cape, by whom it was pronounced to be a diamond worth $2,500. That event marked the birth of the mining industry of South Africa. In 1870 diamonds were found on the open veld in their matrix, and a great rush of adventurers ensued. The mines were in Griqualand West, and the settlement of British rights to the region, in 1871, was not effected without friction with the neighboring Boers of the Transvaal and Orange Free State. Among those who migrated to the diggings was Rhodes, then a boy of eighteen. He went thither from a cotton farm in Natal, whither he had come from England a year previously. In 1871, in a letter to his mother, he described the diamond mines as follows: "Fancy an immense plain, with right in its center a great mass of white tents and iron stores, and on one side of it, all mixed up with the camp, mounds of lime, like ant-hills; the country round is all flat, with just thorn trees here and there."

Rhodes, and his elder brother Herbert, secured three claims, and went to work in earnest. He describes the Colesberg kopje (or hillock), which became the De



A diamond in blue ground

Beers mine later, as follows: "It is like an immense number of ant-heaps, covered with black ants, as thick as can be, the latter represented by human beings; when you understand there are about 600 claims on the kopje, and each claim is generally split into four, and on each bit there are about six blacks and whites working, it gives a total of about 10,000 working every day on a piece of ground 180 yd. by 220." This description may be non-technical, but it indicates an observant and intelligent youth, and it is of special interest to us as coming from the future controller of the world's diamond business.

While Rhodes was still a stripling, he saw the need for consolidating the mines and for operating them in a systematic way. He returned to Oxford, to complete his studies and to obtain his degree. While a student there, he was buying pumping-engines and other machinery for the De Beers, which he had organized as an amalgamation of claims in 1880. He was secretary of the company until 1883, and chairman afterward. By 1885 the capital of the De Beers company had grown to £841,550. He lowered the cost of production from 16s. per carat (3.08 grains) in 1882 to 7s. in 1888. Although the price of diamonds fell, owing to the lavish output, from 30s. per carat to 18½s., within six years, the De Beers company in 1888 paid 25 per cent on a capital of £2,332,170. Space forbids me to tell the story of his conflict with Barney Barnato, and the subsequent consolidation of the De Beers and Kimberley mines, ending later in the creation of one big monopoly. The independent digger ceased to exist for a time. Rhodes himself received $1,000,000 per annum as his share of the gain. He proceeded to use his wealth for the fulfilment of his idea of an expansion of British dominion northward; putting his hand on the map of Africa, up to the central lakes, he would say: "All this is to be painted red; that is my dream." The map today testifies to the success of his purpose.

The manager of the mines during the time of the consolidation was a Californian engineer, Gardner Williams, who remained in charge from 1887 to 1905, when he was succeeded by his son, Alpheus Williams, now the general manager. Thus father and son have directed operations for the De Beers company during a period of thirty-eight years. To Alpheus Williams our party of three was indebted for many courtesies, more especially the opportunity to see how the diamond deposits are exploited.

How Diamonds Are Mined

Our first visit was to the big hole of Barnato's old mine, the Kimberley. This is a crater-like opening, 300 yd. wide, that shows water at 1,100 ft. deep. Across the dark gulf doves were flying. The underground workings extend to a depth of 3,500 ft. Originally, it was a huge open-cast, in which thousands of diggers extracted the diamantiferous ground by aid of ropeways, until the caving at the sides made it imperative to open up the deposit by means of shafts and levels. The edge of the hole shows the geologic formation: 60 ft. of red dolerite, then 300 ft. of black shale, then melaphyre, quartz-porphyry, and quartzite for 2,000 ft.; followed by hornblende-schist, a phase of the basal granite. The diamond-bearing ground occurs as a pipe of brecciated rock, known as kimberlite. It is the "blue ground" of the miners, a peridotite lava, rich in olivine. At surface the "blue ground" becomes yellow, by reason of oxidation—the "lime" of Rhodes' boyish description. The various pipes are connected by fissures, along which in places the kimberlite extends.

The average man believes that the diamonds are recovered without trouble; it needs a visit to the mines to realize the elaborate mining and washing operations entailed in the winning of the precious stones. Formerly the "blue ground" was spread on the surface, and was allowed to disintegrate by mere weathering; now it is crushed, puddled, and concentrated, the last stage of the treatment being the passage of the material over tables covered with grease—a kind of vaseline that holds the gems while allowing the particles of rock to run away. It is curious that this method should have been used long before the flotation process was introduced, although the underlying principle is the same—namely, the fact that the diamond is not wetted, and therefore sticks to the grease, whereas the particles

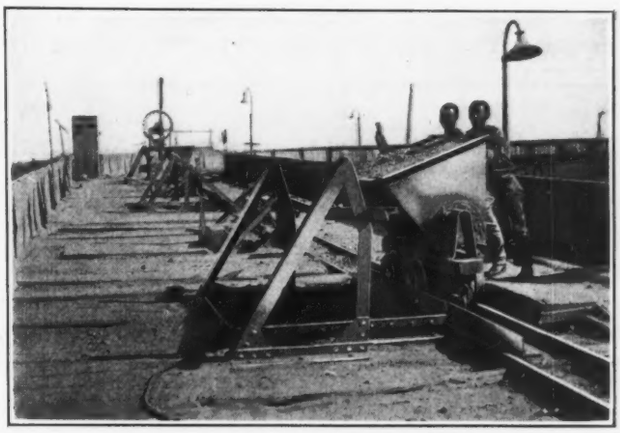
of its rocky matrix are wetted, and therefore escape adhesion. I must reserve the technical details for a later article.

In the central office we saw the check, in a frame on the wall, for £5,338,650, which passed between the liquidators of the Kimberley Central Diamond Mining Co. and the De Beers Consolidated. We saw also a photograph of the largest quantity of diamonds ever swallowed at one time by a native, in the attempt to take them with him out of the compound. He swallowed 348 carats (each carat weighing 3.08 grains), valued then at $5,000, but worth about $10,000 at the present price. The largest stone weighed 45 carats.

Living Quarters of Native Miners

We were taken to see one of the compounds, or inclosures, wherein the natives are segregated. The one we saw, at Bultfontein, contained 1,176 "boys," as the black workers are called. Each one wears a leather band with a brass tag, which is numbered. The pay ranges from 3s. to 5s. per shift. From the compound the workers go to the mine-station through a tunnel 30 ft. below the surface. They do not leave their quarters during the contract period, which is at least four months. We happened to visit the compound on a Sunday, a day of rest, legally enforced, when they are permitted to receive visits from their women and other friends, who exchange greetings with them through an aperture in the fence. They give money to their wives, and receive food sometimes in return. They cook their own food, which they buy from the company, but they are supplied with water, wood, or coal. Their sleeping quarters are berths made of cement, whitewashed every three months. The one-story shelter that contains their cubicles extends continuously around three sides of a square, in the center of which they have facilities for washing themselves and for washing clothing—such as it is. The men are mostly of the Bantu race, and appear to be vigorous specimens of humanity. They stroll across the compound in blankets of brilliant hue, squat on the ground stolidly, or lie prone in the warm sunshine. We saw one of them making a quilt out of tobacco sacks. Another was working a sewing machine. Some were gambling with cards, although this is against the rules, and they stopped playing on our approach. They cook their food on fire-pans and braziers, sometimes within, but usually outside, the places where they sleep. Opening one or two pots, we found meat and beans being stewed. On Sundays they have religious services according to their choice—Wesleyan, Episcopal, or Presbyterian. We heard singing and found a gathering of thirty workers under the leadership of a lay reader of their own color. The singing was loud and rhythmical, but not musical; it was a weird chant, which seemed to me depressing rather than cheerful. The natives, however, are of a cheerful temperament, like children, and they seem to have infinite patience. Some of them remain in the compound for two years, although most of them leave it for a few days before renewing their contract of four, six, or eight months. No recruiting is necessary; the natives come voluntarily—a fact that speaks well for the treatment they receive at the hands of the company. The De Beers company employs 5,200 natives and 1,800 white men.

The success of the diamond mining has depended mainly upon the control of the output and the adjustment of the supply of gem-stones to the demand. Rhodes told his shareholders, at a meeting in London, that they would be sure of their dividends so long as men were foolish and women were weak, which meant that profits were assured until the Greek kalends. Today, however, the De Beers diamond syndicate no longer exercises a complete monopoly, for the river diggings in the Orange Free State, near Kimberley, produce annually £2,000,000 worth of diamonds. Still more serious is the competition caused by the production from Southwest Africa, the Belgian Congo, and the Portuguese territory of Angola. Recently a bill has been introduced in the legislature to give the control of the diamond output to a committee to be appointed by the government, but it is to be hoped that a step so detrimental to real economics



Tipping platform and washing machine

will not be taken. In the days of Rhodes the De Beers controlled the legislature, but the company was so generous in public works and benefactions that inimical legislation was stifled. The generosity of Rhodes was a form of voluntary taxation.

We left Kimberley at 4 p.m. on April 6 and reached Johannesburg at 6:15 next morning. Approaching the Vaal (pronounced Faal by the Dutch), we saw some old diamond diggings that had been started thirty years ago. About 100 men are working there now, but the chief centers of alluvial operations are at Bloemhof and Potchefstroom. The train passed a cart pulled by twelve burros. The old friend of the American prospector is used much in this part of Africa, because he is better adapted to the climate than is the horse. At Kimberley we saw many handsome mules bred by the De Beers company. The horse, unfortunately, is the victim of various flies, the worst of which is the tsetse, a pest to all domesticated animals as one goes north into Central Africa.

We crossed the Vaal at sunset, and awoke in time to obtain an impressionist picture of Johannesburg. The morning mist still lingered; it magnified the great gray dumps that marked the course of the Main Reef; they were framed in a forest of eucalyptus, the feathery foliage of which softened the mechanical lines of shaft-houses and mills. The panorama—for the passage of the train gave us a continuing picture—left an impression of titanic industrial effort and adequately fulfilled our imagination of the greatest gold-mining center in the world, the Rand, which last year produced $200,000,000 in gold.

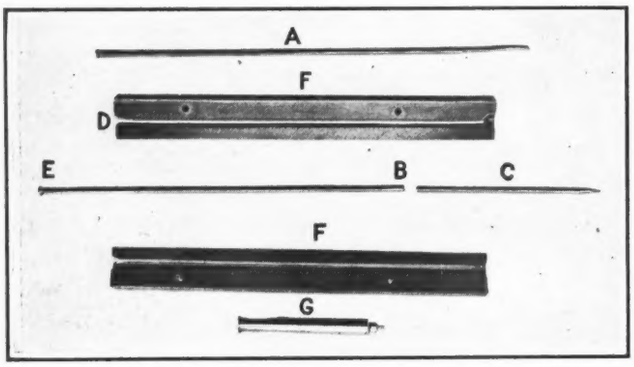
Useful Operating Ideas

Making and Repairing Rock-Drill Water Tubes

By William J. Coulter

Assistant Mine Superintendent, Granby Consolidated, Anyox, B. C.

An idea that has been in successful operation for some time by the Granby Consolidated Mining, Smelting & Power Co. at Anyox, B. C., involves the repairing of broken rock-drill water tubes and the making of new ones. The saving effected by this work amounts to considerable in the course of a year, as broken tubes are the



Repairing rock-drill water tubes

most common item of expense contributing to the upkeep of the rock drill. It is the practice at Anyox to require a miner to return the broken tube, which is subsequently repaired as follows: The tip is first sawed off 4½ to 9 in. from the end at *A*, in the accompanying illustration, the butt end *B* is then reamed out with a brace and three-cornered file, or similar reamer, the new tip end of proper length is then tapered on an emery wheel at *C*, and with the aid of a blow torch a soldered joint is made at *A* by sweating. When it is necessary to renew the tip, the joint is broken at *A* by heating and a new tip is put on as before.

New butts are made in a set of dies, *F*, from seamless tubing of standard size. The tubing comes in random lengths up to 20 ft. and the sizes carried in stock are $\frac{5}{8}$ in. outside diameter, 21 gage; $\frac{7}{8}$ in., 18 gage, and $\frac{1}{4}$ in., 18 gage. A piece of tubing of proper butt-end length is placed in the dies and securely clamped in an ordinary bench vise. One end of the tube is then heated with a blow torch and the beading *E* is put on in slot *D* with the aid of tool *G*.

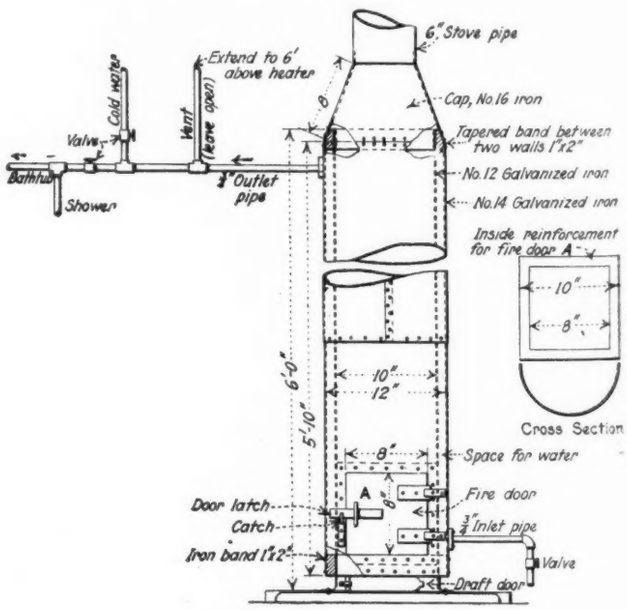
The work of making and repairing water tubes is done by the drill repair men in their spare time, and as the old butts are returned by the miners, most of the work comes in repairing or replacing tips. This is quickly and efficiently done, and it is seldom that a tip comes loose at the joint. Most of the tubes made and repaired at Anyox are for the Denver Rock Drill Co. M-21 Turbro, but tubes for other makes of drills are repaired as well, hence several different sizes of tubing are carried in stock.

The equipment used for making and repairing the tubes consists of a small electrically driven emery wheel, a brace and reamer, a form or set of dies, a beading tool, a blow torch, a bench vise, and the tubing.

About ten minutes' time is required to repair a water tube, and the cost of this work is charged to the machines at the rate of 8c. for the butts and 7c. for the tips.

Hot-Water Heater

A simple type of hot-water heater that can be made in the mine shop will serve to provide hot water for a tub and shower or two showers, as shown in the accompanying figure. The heater was designed and is in use at the Plymouth mine, Plymouth, Calif. It supplies hot water for the mine foreman's office. The heater is constructed of an inner wall, No. 12 galvanized iron, and an outer wall, No. 14 galvanized iron. The two walls are separated by a 1-in. water space. At the top the inner and outer sheets are riveted to tapered iron ring, 1 in. in thickness. A bottom ring, 1x2 in. in section, is placed between the sheets at the bottom and a frame forms the fire door. A thin sheet-iron frame, with draft door, is placed below and furnishes the support of the heating tank. A conical cap of No. 16 iron is riveted to the top and connects with a 6-in. stove-pipe. All of the joints are riveted and soldered. A $\frac{3}{4}$-in. water pipe is tapped into the bottom and at the top of the water space a pipe of the same size connects with the plumbing. A vent pipe extending to a height of 6 ft. above the top of the water space provides for the escape of steam and guards against excessive pressure. A small wood fire suffices to heat the water quickly.

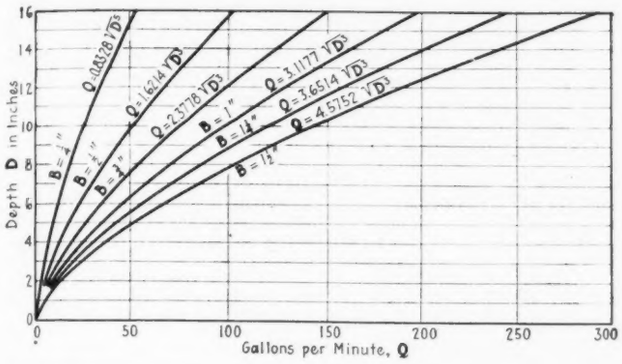


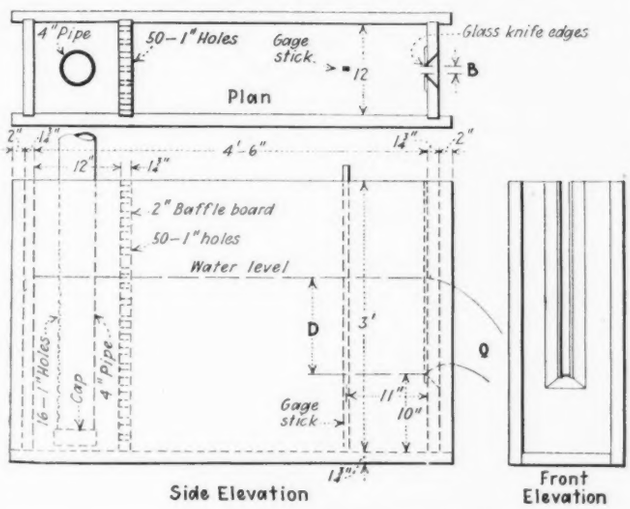
Details of hot-water heater

Flow of Water Through Narrow Weirs

By Harold A. Linke

In mill operations, especially experimental work, it is frequently highly desirable to know the quantity of water added at various points. The accompanying figure shows a simple weir box for the purpose of measuring water flow. Curves and their respective formulas for the discharge of weirs of the following widths: ¼ in., ½ in., ¾ in., 1 in., 1¼ in., and 1½ in., are also shown.



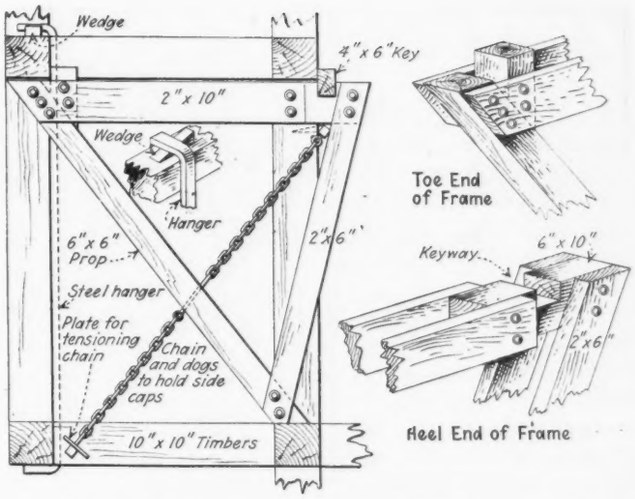


Above—Curves for determining flows of water through narrow weirs. Below—A simple weir box

Timber Frame for Underhand Square Setting

By George J. Young

Underhand stoping with square set timbering was described by Robert H. Dickson in the *Mining Journal-Press*, Jan. 6, 1923, p. 5. In this method of stoping the suspended square sets are supported by stulls and nailing strips or by a boom with nailing strips to hold the lower members of the square set. In the accompanying sketch three separate devices are used for the purpose of holding the loose set and supporting the square set timbering above the undercut. The triangular-shaped frame carries the principal weight of the sets above the undercut set. Two frames are used, one on each side of the set. These are bolted together for convenience in getting them into the stopes. The lower side caps are held by a chain with a dog at each end for driving into the timbers. The dogs will hold in seasoned timber, but are apt to pull out of green



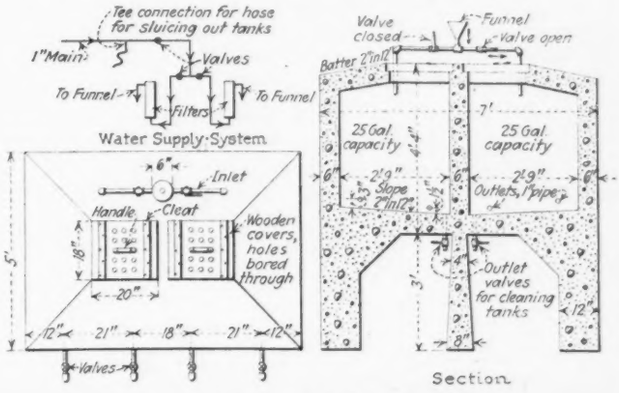
Details of support for underhand square sets

timbers. A plate is attached to the lower dog so as to enable tension to be put upon the chain before driving the dog. Two chains with accessory dogs are required. The front lower cap is held by a hanger which consists of a light rail bent at each end. This is tightened in place by a wedge, as shown in the illustration. As soon as the lower set is under cut and the new set blocked, the triangular frames are removed and placed in position on the new set; the dogs are knocked out and the chains placed also on the new set. The hanger is then removed and similarly placed on the set below.

Concrete Water Tank for Station Use

A concrete water tank to supply drinking water at shaft stations has been designed and is in use at the Plymouth mine, at Plymouth, Calif. The walls and bottom are 6 in. thick, as shown in the accompanying illustration. The top of the tank, which is square in section and divided into two compartments, is drawn in and closed by a wooden cover pierced with holes. Each compartment contains 25 gal. and is provided with two outlets. A bottom outlet is also provided for cleaning out the tank. The concrete top is lightly reinforced.

The tank is supported on concrete piers at a convenient height. A 1-in. water main supplies the water to the station. The water is passed through a pair of simple pipe filters and thence to a funnel which connects to a pipe leading to either compartment. The tanks keep the water cool and have proved efficient.



Concrete water tank for station use

Discussion

What Right Has a Prospector in the Warren Mining District?

THE EDITOR:

Sir—On June 4, 1925, the subcommittee on public land of the United States Senate held a meeting in Douglas, Ariz. At this meeting matters pertaining to the administration of the public domain were discussed. Data were presented in order to show the injustices done the miner and prospector of the Warren or Bisbee mining district. A case not presented but of almost pathetic interest is that of M. J. Corrigan and H. B. Kendrick, partners. These two men are old-time miners and prospectors in Bisbee, both having worked here for many years. In 1910, 1911, and 1912, Corrigan and Kendrick located several claims in what is known as the Don Luis section of the Warren district. The necessary work has been done each year up to and including 1924.

On Jan. 13, 1914, knowing that this ground was being held as mining claims, Lloyd L. Stewart made a homestead entry covering this area. On Feb. 4, 1915, Lew C. Gonzales, another partner of Corrigan and Kendrick, filed a protest against the said entry. A hearing was held and a decision was rendered dated April 24, 1917, as follows: "The department found that no discovery of a vein or lode had been made upon the mining claims; that there was no satisfactory evidence of any mineral deposits underlying the land; that the said land was subject to homestead entry because it contained areas which might be cultivated."

Appeals were made which finally brought the case to the First Assistant Secretary of the Interior Department, whose decision includes the following:

"The land is stony, the covering of soil is thin, and the rainfall is very light, but it cannot be denied that the land will produce vegetation to some extent. The homesteader may not have shown good judgment in choosing this land for agricultural purposes, but, in the absence of proof that it was taken for mineral, for speculative purposes or for any other than agricultural use, there is no ground for holding that the entry could not be lawfully made."

The technical profession of Bisbee without avail had risen to the defense of Corrigan, Kendrick, and Gonzales. J. B. Tenney, geologist for the Copper Queen since 1911, testified that the Stewart homestead was a reasonable prospect and that a man would be justified in developing it. Roger T. Pelton, chief engineer for the Copper Queen, testified that ore might be encountered at a depth of perhaps 500 ft. from the surface. William B. Gohring, mine superintendent of the Calumet & Arizona Mining Co., testified as to the mineral character of the ground. Prof. I. Bonillas, geologist for the Phelps Dodge Corporation, testified that there were great possibilities for commercial ore under the Stewart homestead. The evidence presented by these highly trained experts was entirely ignored.

How could Corrigan, Kendrick, and Gonzales prove that Stewart made his homestead entry for any other purposes than agricultural? Disinterested parties have but to look at the land and study the history of the district to form their own opinions as to why anyone would think that this ground was valuable. Nothing has been grown successfully, nothing will ever be grown profitably. Contrast these contestants. Stewart made an attempt at cultivation, without result. Corrigan and Kendrick for years worked for the Bisbee mining companies and each time they accumulated a few dollars they worked on their claims. Think of it—they sank a shaft 362 ft. deep through solid rock in their earnest endeavor to find and make a mine and a "stake."

The Stewart homestead patent has not yet been issued, but when it is the hopes, the years of toil, the honest endeavors of two old prospectors will be wiped out and gone forever.

The shaft that they have sunk will remain a monument of miscarried justice to the prospector. The rocky barrenness of the Stewart homestead will never be covered by crops. The "old timers" at Bisbee have a very fixed idea why that homestead entry was made.

Bisbee, Ariz. M. J. ELSING,
Chairman Mining Committee,
Bisbee Chamber of Commerce.

Consultation

A Directory of Mining Companies

"I would be glad if you could refer me to a directory or other source giving the names and plant addresses of all non-ferrous mining, smelting, and refining companies in the United States, and if possible, those in the other parts of the Americas, and Africa, Australia, China, etc. The information is wanted from the viewpoint of one who is simply an analytical and metallurgical chemist."

The best and most complete directory of non-ferrous mining, smelting, and refining plants is "The Mines Handbook," by Walter Harvey Weed. A new edition of this book has recently been published by the Mines Handbook Co., Tuckahoe, N. Y., the price being $15. It gives the names and addresses and much other information regarding practically every mine and prospect in the United States and Canada, and also a large number in other parts of North and South America. It does not, however, cover any of the other continents. For Europe, Asia, Africa, and Australia, the best directory is "The Mining Manual," published by Walter E. Skinner, 15 Dowgate Hill, London, E.C. 4, England. The price is 21s. 6d.

Buyers of Lead Ore Abroad

"Please give names and addresses of two or three lead-silver smelters or ore buyers, near London, England, or Belgian firms. I have a quantity of ore to ship from the west coast of Mexico."

The following companies are possible purchasers of lead ore to be smelted in Belgium or England: Cookson Lead & Antimony Co., Ltd., Howden-on-Tyne, Northumberland, England; H. J. Enthoven & Sons, Ltd., Rother Lithe, England; Quirk, Barton & Burns, St. Helens, Lancashire, England; Cie. des Metaux Overpelt-Lommel, Overpelt, Belgium.

News of the Week

The Mining News of ENGINEERING AND MINING JOURNAL-PRESS is obtained exclusively from its own staff and correspondents, both in the United States and in foreign fields. If, under exceptional conditions, material emanating from other sources is published, due acknowledgment and credit will be accorded.

Summary

STOCKS OF COPPER in the hands of American producers totaled only 85,000 tons on July 1 according to reliable estimates. This is the lowest point reached since the war.

A body of lead-silver-zinc ore has been followed 400 ft. in the Stemwinder mine near Kimberley, B. C.

A shutdown of the Dos Estrellas mine at El Oro, Mexico, may follow the refusal of the demands of the miners, for pay on "rest" days.

Mohawk was the lowest cost producer of copper in the Michigan district during 1924; 11.4c. before depreciation.

F. W. Bradley and associates have obtained options on low-grade gold-silver properties near Fairview, Nev.

Good progress is being made in the excavations for the new leaching plant of the Inspiration Consolidated Copper Co., in Arizona.

At the Chino Copper mine, 3,750 cu.yd. of rock was loaded recently in an eight-hour shift by one electric shovel. May be a world's record.

The construction of a mill at Bay Horse mine in Oregon will follow purchase of the property by the Primos Chemical Co.

No commotion was caused by the transfer of the Bureau of Mines to the Commerce Department on July 1.

Sharp curtailment of production in the Joplin-Miami zinc-lead district is the program for early July.

Develop Stemwinder, Near Sullivan Mine, Kimberley, B. C.

Drift 400 Ft. on 25-Ft. Vein of Milling Ore—Lead and Zinc Mixture —British Interests

The Stemwinder mine, near Kimberley, B. C., is looking good under development, according to a statement recently given out by O. C. Thompson, one of the principal owners of the property. The mine, together with the North Star and Ontario properties, was taken over under a 3-yr. lease and option by the Porcupine Goldfields Development & Finance Co. about nine months ago, and a vigorous campaign of development was commenced. New machinery was added, a spur was made to the Canadian Pacific Railway tracks, and the property was connected with the East Kootenay Power Co.'s system. The 50-ft. shaft was extended to 125 ft., at which point a drift was started in each direction on a shoot of milling ore; this drift now has been driven for 400 ft. in milling ore and both faces still are in ore; two crosscuts driven through the oreshoot give it a thickness of 25 ft.

Recently a crosscut has been started to develop at depth a parallel shoot in the same mineralized belt. In the upper working this shoot was 200 ft. wide. Besides the foregoing, the company has driven four tunnels and drilled twenty-seven diamond-drill holes. The development now under way is producing sixty to seventy tons of ore per day. The ore is similar to that in the Sullivan mine of the Consolidated M. & S. Co., the main difference being that it carries more pyrrhotite and less pyrite; the lead and zinc content is about the same. The development of the property will be pushed.

Dos Estrellas Miners Want Pay for Holiday; May Strike

EMPLOYEES at the Dos Estrellas mine at El Oro, Mexico, have made demands on the company for payment for days known as "rest" days, according to reports from Mexico City. Employees, according to law, are entitled to rest one day each week and they now demand that the company pay for that time. The company, answering the demands, states that owing to the low profits it is impossible to comply. A strike to close down the mines is threatened. More than 3,000 men are employed.

New Candelaria Produced 22,000 Oz. Silver in May

Silver production by the New Candelaria Mines Co. for the month of May was 22,000 oz., which is above the rate for recent months.

The increase is attributed to the sulphide ores on the 1,700 level, where a 10-ft. vein is being developed and stoped. This sulphide ore is not only of better grade than the old fills and pillars of the upper levels but a better mill extraction, of around 78 per cent, can be obtained from it.

Good Showing in Chalk Mountain Silver-Lead District

Nevada Camp Ships $90 Ore—Several Development Projects Under Way—Minneapolis Capital Interested

The Chalk Mountain silver-lead mining district, in Churchill County, Nevada, about 45 miles easterly from Fallon, is showing up well, both in development and production.

The principal producer to date is the original property owned by the Chalk Mountain Silver-Lead Mines Co., controlled by Minneapolis capital. This company has sunk a two-compartment shaft 200 ft. deep and will continue to a depth of 260 ft., cutting stations at the 210 and the 260 levels. Development work has been carried on only from the 110, 130, and 160 levels, and production of ore above the 160 level has totaled eighteen cars, which averaged $90 per ton. The south drift on the 160 level is in high-grade ore and it is estimated that the block between the 160 and 110 levels contains at least thirty cars of shipping ore of about the same grade as that already shipped. The main vein strikes slightly east of north, with a flat east dip, and the ore shoots rake southerly.

The Nevada Chalk Mountain Extension Mining Co. has a two-compartment shaft already down 110 ft., the shaft being located about three-fourths of a mile south of the Chalk Mountain shaft. Company engineers estimate that the shaft will cut the vein at about 225 ft. depth. Many prospectors are busy on small work, some of whom have opened favorable showings.

Mohawk Copper Production Costs Lowest in Michigan

Total 11.4c. Before Depreciation and Depletion in 1924—Isle Royale Next, Then Calumet & Hecla Consolidated

MOHAWK is the lowest-cost producer of the mines in the Michigan copper district. Its cost per pound of refined copper, before depletion and depreciation, is 11.4c. Mohawk charges off 4.7c. for depletion and depreciation, making a total of 16.1c. Production last year was 15,215,197 lb. The price received for copper was 13.51c. Depletion and depreciation charges were $728,778.

Isle Royale, subsidiary of Calumet & Hecla Consolidated, produces copper at 12.63c. per pound, before depletion and depreciation. The depletion and depreciation charge is 3.78c., making total cost 16.41c. The mine's production last year was 8,103,000 lb. The price received for copper was 13.16c. Depletion and depreciation charges were $306,406.

Calumet & Hecla Consolidated produces copper from its mines at an average cost, sold, of 12.48c. per pound, not including depletion or depreciation. Five cents per pound is charged off for depletion and depreciation, making total cost of mine copper, 17.5c. Copper from the Calumet reclamation plant is produced at an average cost sold of 7.83c. per pound, or 12.83c. with depletion and depreciation charge added. Production from the mines of the company last year was 54,510,000 lb., and from the Calumet reclamation plant, 18,627,000. The average price received for copper was 13.05c. Depletion and depreciation charges were $3,693,191.

It costs Copper Range 12.9c. to produce a pound of refined copper, exclusive of depletion and depreciation. Only one-half of the production of the Champion mine is included in the calculation, as one-half of this property is owned by the St. Mary's company. The depletion and depreciation charge is 4.9c., making total cost 17.8c. Production last year was 15,078,360 lb. The price received for copper was 13.76c. Depletion and depreciation charges were $740,893.

Quincy cost per pound, exclusive of depletion and depreciation, averages 14.2c., sold. This price includes Michigan and capital stock taxes, construction and accident accounts. Production last year was 14,838,633 lb. The average price received for copper was 13.67c. The company realized $43,074 for silver produced. Although Quincy reported a deficit of $79,489.01 for 1924, the mine operated at a profit of $40,000 during the first quarter of 1925, on account of the higher selling price for copper, production for the quarter being 4,100,000 lb. Due to certain improvements in equipment and mining practice, Quincy's cost per pound should be shaded this year. It shows for the first quarter a reduction of more than ½c.

Ore Shipments Up at Bingham and Park City

Production in Utah mining districts was higher during the last week of June than during the preceding week. The Park-Utah company shipped to the smelter 4,000 tons, believed to be the largest weekly output of any property in the history of the Park City district. Total production of ore and concentrates for the week from the district amounted to 8,475 tons, compared with 7,009 tons for the preceding week. Production, in tons, for the last two weeks compare as follows:

	Fourth week	Third week
Park-Utah	4,000	3,225
Silver King Coalition	1,615	1,158
Park City Mining & Smelting	1,338	1,146
Ontario	1,208	920
Keystone	215	560
Total	8,475	7,009

Production of ore, concentrates and precipitates from the mines of the Bingham district for the last week increased to 162 carloads, compared with 152 carloads the previous week. This is exclusive of the output from the Utah Copper and the Utah-Delaware mines. Shipments, in carloads, from reporting mines of the district during the last two weeks were as follows:

	Fourth week	Third week
Utah-Apex	73	71
United States	68	65
Bingham Mines	13	10
Ohio Copper (precipitates)	3	2
Utah Metal & Tunnel	4	0
Montana Bingham	1	0
Park-Bingham	0	4
Total	162	152

Production of ore and concentrates from the Tintic district totaled 157 carloads, compared with 165 carloads the preceding week. Shipments, in carloads, from the various mines of the district for the last two weeks are as follows:

	Fourth week	Third week
Chief Consolidated	54	48
Tintic Standard & Iron Blossom	42	51
Bullion Beck (dump ore)	38	40
Bingham Mines	11	9
Plutus	2	3
Mammoth	5	5
Zuma	1	0
Dragon	1	1
Mountain View	1	0
Alaska	1	2
Colorado	0	4
Silver Park	0	1
Empire Mines	0	1
Total	157	165

Primos Chemical Co. Acquires Mining Property in Arizona

The Primos Chemical Co., of Philadelphia, has purchased the Red Cloud, Papago, and Ace High silver mines north of Yuma, Ariz. It is stated that the consideration for the Red Cloud mine and mill site was $50,000; the Papago Extension $25,000, and the Ace High and six other claims $3,500.

The Red Cloud is an "antigua," said to have produced $3,000,000 in shipping ore in the '80s. All high-grade is said to have been exhausted to the water level, but ore dumps and pillars are reported to average 5 per cent lead and 10 oz. silver per ton. Modern machinery is to be installed and the mines operated on an extensive scale, according to reports.

Hollinger Interests Back Amulet Development in Rouyn, Que.

At the special general meeting of the Amulet Gold Mines, Ltd., which is opening copper-gold properties in the Rouyn area in northwestern Quebec, held in Montreal a few days ago, the shareholders approved the proposal to increase the capital from $2,000,000 to $4,000,000 and exchange the outstanding stock on the basis of two shares for one. The official connection of N. A. Timmins in the financing of the company was announced at the meeting and the number of directors was increased from five to seven to provide seats for Mr. Timmins and J. I. Rankin, also of the Hollinger company. A diamond drill is now on the ground and will shortly start work; in the meantime surface trenching and sampling is being continued. In the veins of the original cut from No. 1 trench, where the greatest depth has been reached, the gold content is $12 per ton and copper 9 per cent. The surface sampling should be completed within a few weeks, when the results will be made known.

Iron Cap Curtails; Superior & Boston Finds New Ore

The directors of the Iron Cap Copper Co., of Copper Hill, Ariz., have decided to curtail production until the price of copper advances sufficiently to make operation profitable. The concentrator was shut down on June 30 and mine operation will be reduced to 25 per cent of present scale. Output will be shipped to the International smelter at Miami.

The Superior & Boston, a neighbor of the Iron Cap, has made an encouraging discovery of ore in the North vein east of the Mescal fault about 75 ft. above the 800 level. The vein is from 4 to 5 ft. wide, runs 4 per cent copper and 12 oz. silver. The drift along the vein is now about 80 ft. long and is still in ore. The new discovery is the farthest east of any ever made by the company in the North vein.

North Standard Looks Good

With the appearance of small lead-carbonate boulders in a drift below the 850 level, conditions at the North Standard mine in the Tintic district in Utah are favorable, according to John Dorius, president of the company. The boulders were encountered a short time ago and development work is being pushed with the hope of finding the ore in place.

The objective of the company is an intersection of a porphyry dike and fissure with an east-west break, where a north-south fissure is expected to make intersection.

Duthie Mines Will Be Reopened by J. F. Duthie

Property Abandoned by Federal M. & S. Co. After Year's Work—Some Good Ore Shipped

After a shutdown of nearly a year, the Duthie mines, on Hudson Bay Mountain, fourteen miles from Smithers, B. C., will be reopened by J. F. Duthie, of Seattle. J. R. Turner, engineer for Mr. Duthie, is en route from Seattle to the property. Negotiations between Mr. Duthie and the Federal Mining & Smelting Co., which operated the property for a year under a 55 per cent interest arrangement, were terminated in August, 1924.

The Duthie mines are well equipped for operation, and have shipped extensively in the past. A power plant has been installed, giving plenty of power for all purposes. Under the Federal operations, 1,100 ft. of drifting and crosscutting was done, divided among the McPherson tunnel, Intermediate and Compressor levels. The McPherson tunnel has been extended 320 ft. This work was done on the Henderson claim. No work was done on the Mamie claim from November, 1922, until the completion of the steam plant made it possible to resume operations in August, 1923. This property had been developed by a drift tunnel and winzes and then a low level crosscut tunnel was commenced and driven about 200 ft. The Federal management ran a lower drift level on the vein before carrying ahead the crosscut tunnel, and this drift was started at a point 150 ft. below the upper drift tunnel and in line with the strike of the vein. When operations ceased by the Federal company, this level was not in far enough to give any additional information about the Mamie vein. During the period of operation of the property by Mr. Duthie about 320 tons of hand-sorted ore was shipped from the Henderson. Under the Federal régime, production was about 620 tons.

Chief "Con" May Absorb Plutus at Tintic, Utah

The absorption of the Plutus Mining Co. by the Chief Consolidated Mining Co., operating in the Tintic district in Utah, is proposed in a letter being sent to shareholders by Walter Fitch, president of the Chief Consolidated. The Chief Consolidated has owned control of the Plutus stock for some time.

The proposed merger gives an exchange basis of five shares of Plutus for each share of Chief Consolidated.

Stockholders of the Plutus have tried many times to execute such a transaction, but owing to the suggested rate of exchange, directors of the Chief Consolidated have heretofore objected. The present offer has been agreed upon by directors of the latter company and the offer will stand until July 31.

The Chief Consolidated, one of the largest producers in the Tintic district, recently returned to a dividend basis. The Plutus is only a small producer, but has large tracts of undeveloped ground.

Leadore to Enlarge Mill

C. M. Nicholson, manager of the Leadore mines at Leadore, Lemhi county, Idaho, reports that the mill will be increased to 150 tons from 50 tons. The expenditure on mill, classifier, flotation machine, and filter will be $35,000. More than 600,000 tons of ore is in sight, it is said. The average content is 9.66 per cent lead and 6.7 oz. silver. Based on a production of 150 tons daily, the cost of mining, concentrating, freighting and smelting ore is estimated at $8 a ton.

Work Progresses on New Inspiration Leaching Plant

Concrete Vats Will Have 7,500-Ton Capacity—Ore to Be Crushed to ¾ In. for Treatment

The leaching plant of the Inspiration Consolidated Copper Co. at Inspiration, Ariz., now under construction, is expected to be completed in September, 1926. The principal part of the excavation has been finished and the erection of reinforced concrete extensions to the fine-crushing unit is now under way. The plant has been designed by A. G. McGregor of Warren, Ariz.

Excavating for the Inspiration leaching p'ant

This plant, modeled after that at Ajo, will have a capacity of 7,500 tons of mixed sulphide and oxidized ore per day

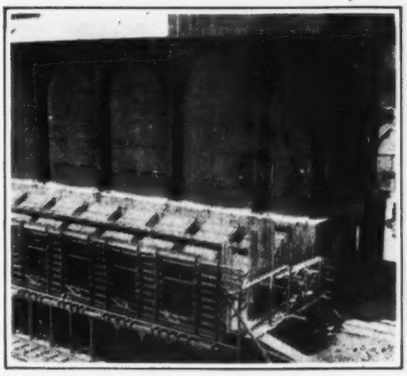
The general layout will follow closely the Ajo leaching plant. There will be thirteen leaching vats, 70 x 175 ft. x 18 ft. deep, contructed of reinforced concrete. Each vat will have a capacity of 7,500 tons, which also will be the daily tonnage treated. Ten tanks, each of 450,000-gal. capacity, will be used for solution storage. These will also be constructed of reinforced concrete. The tank house for copper deposition will be arranged after standard practice. The tailings will be handled by a 15-ton excavator and transported over a 2½-mile railroad to the dump. A side-dump car similiar to the ordinary spoil car will be used for this service. Grading will amount to 300,000 cu.yd.; structural steel, 1,600 tons, and reinforced concrete, 42,000 cu.yd.

It is expected to crush the ore to ¾-in. size in two crushing stages, using four 78 x 24-in. rolls in closed circuit with vibrating screens. The crushed ore will be conveyed directly to the leaching vats.

The structural steel is now being fabricated, but no machinery contracts have been placed as yet. G. H. Booth is in charge of the construction work. H. W. Aldrich is metallurgist in charge at Inspiration, and G. D. Van Arsdale of Los Angeles is consulting metallurgist.

Unwatering at Grass Valley

The Golden Center mine, at Grass Valley, Calif., has been unwatered, and mining is expected to be resumed at once. The Idaho-Maryland, which has been relinquished by the Metals Exploration Co. after the expenditure of large sums in exploration, is being kept unwatered pending the arrangement of leases. The Dull mine, in the Newtown area, is being kept drained, but plans for working have not been completed. The New England mine has been unwatered, and local reports indicate that a good showing has been exposed in the old drifts.



Building new concrete ore chutes beneath the bins at Inspiration's old shaft

F. W. Bradley Options Fairview, Nev., Properties, Is Report

Possibility of Developing Large Low-Grade Enterprise—Ore Contains $4 Gold and Silver

It is reported in Nevada mining circles that the F. W. Bradley interests, of San Francisco, have obtained working options on two properties, the Homestake and the Jellineck, in the Fairview mining district, and that work has been started.

The Homestake or Stockton property is situated about eight miles southeast of Fairview, and on this ground a large calcite and quartz vein in rhyolite, at times over 50 ft. in width, has been drifted on for 600 ft., with a maximum depth below surface of 360 ft., in a 250-ft. winze from this drift. Most of this work was done by the Nevada Wonder Mining Co., which company held an option on the ground in 1920. A strike fault was encountered in the winze and drift, which discouraged further work. The ore is said to average around $4 per ton in silver and gold, with occasional bunches of richer ore along the footwall of the vein, but the tonnage may be large, and if so, might well justify the erection of a large milling plant.

The Jellineck property is situated about seven miles southeast of Fairview. Limited development on this property indicates a large low-grade vein in rhyolite, somewhat similar to that on the Homestake.

Canadian Mexican Gold Mines Gets Viznaga Property

The final payment on the Viznaga mine at Alamo, Lower California, has recently been made by the Canadian Mexican Gold Mines, and the company is now planning to carry on the development necessary in the lower levels of this well-known gold producer.

Gold mining operations in Lower California have been somewhat curtailed during recent years, but interest in the Alamo camp has been renewed and is now accentuated by the favorable reports of development on various properties. The work of greatest magnitude is that just undertaken by the Potrero company, which has acquired such well-known producers as the Princessa, Aurora, and San David.

French Copper Imports Decline

Raw copper to the amount of 22,310 metric tons was brought into the port of Havre, France, during the first quarter of 1925, this being about 12 per cent less than the total imports (25,393 tons) imported during the preceding quarter, and about 12½ per cent less than those for the first quarter of 1924. Of the total importation during the first three months of 1925, imports of raw copper from the United States accounted for approximately 73 per cent. Chile came next, furnishing 26 per cent. The imports from the United States for the quarter decreased 29 per cent from those for the final quarter of 1924—from 23,107 tons to 16,224 tons, according to Samuel J. Fletcher, Consul at Havre.

Ore in Ione Mine

Reports from the Ione mine, located near Murray, Idaho, are that more than 2 ft. of first-class lead-zinc ore has been uncovered in the drift on the vein and that the showing of ore grows better as work advances. The ore was encountered at a depth of 125 ft. when the drift had been extended 190 ft. H. O. Solum is managing the development work.

Is This a World's Record for Loading?

A NEW RECORD for power-shovel loading at the Chino mines of the Ray Consolidated Copper Co. in Santa Rita, N. M., was made recently. The huge electric shovel loaded 3,750 cu.yd. of rock in one 8-hr. shift. This shovel is a Marion Model 350 E, equipped with an 80-ft. steel boom, 55-ft. dipper handle and 8-cu.yd. dipper; twenty-three trains of five 30-yd. dump cars each were loaded and carried to the waste dump in the 8-hr. period. This means that the 8-yd. dipper was loaded and dumped at the rate of once each minute for the full eight hours, an average that necessitates almost ideal loading conditions and permits only very little delay in the spotting of trains and stopping of the machinery for adjustment or repairs. Two men, Ike Kennedy, operator or runner, and Harold Kelsey, electrician, constituted the crew when the record was made on the 3 to 11 o'clock shift on Thursday, June 25. A total of more than 10,000 cu.yd. was handled during the full 24-hr. period in which Kennedy made the record for his 8-hr. shift.

Reports of Rich Lead-Silver Ore at Darwin, Calif.

Disclosures of great importance have been made at two of the properties of the Acme Mining Co., a subsidiary of the Continental Development & Reduction Corporation, at Darwin, twenty miles southeast of Keeler, Calif. John D. Fields, consulting engineer, states that in glory-hole operations at the Bunco Billy property there has been exposed a 9-ft. width of sulphide ore that assays 26.9 oz. silver, 15 per cent copper, 17.5 per cent lead, and 8.8 per cent zinc. This orebody dips to the west on an angle of about 45 deg. Lying immediately above it there is 4 ft. of carbonate ore yielding 7.2 oz. silver, 7 per cent copper, 26 per cent lead, and 11.7 per cent zinc. In enlarging and straightening the shaft on the Fairbanks property 3 ft. of galena ore has been disclosed at the 50-ft. point on the footwall side of the working. This entire width of ore, Mr. Fields states, gives average assays of 91 oz. silver and 70 per cent lead, with no copper or zinc content. Thus far this orebody has been stripped up the shaft 20 ft. and down 30 ft. The shaft, now down 110 ft. will be continued to 125 ft., where a station will be cut and stoping started.

Numerous Transactions in Joplin-Miami Zinc Mines

New Mill on Vantage Lease—Rogers Will Move Lee Burch Mill—Much Drilling

Midsummer finds steady activity in the Joplin-Miami district. Some properties have been transferred, a few are being abandoned, and considerable prospect drilling is being done.

O. Rogers, of Webb City, Mo., has purchased the Lee Burch mill, now located near Four Corners, northwest of Joplin, and will tear it down and move it to the Parker lease, south of Carthage. The move follows several months drilling by Rogers on the Parker lease.

R. L. Jensen and associates are building a new mill on the east portion of the Vantage lease, in the Oklahoma field. The Vantage company has closed down its No. 2 mill for an indefinite period and will carry on an extensive drilling campaign.

The Tulsa-Quapaw Mining & Investment Co. has taken a drilling option on the Jack & Jill mine, near the Kitty, southwest of Picher. The Admiralty Zinc Co. has started its No. 5 mill in the northwest Joplin field. The Universal Exploration Co., subsidiary of the U. S. Steel Corporation, is operating a number of drill rigs on the Gascho lease, in the Waco., Mo., section of the district. B. E. Brown, of Joplin, has sold his interest in the Racetrack mine, west of Baxter Springs.

Belgian Zinc Industry's Profits Improved in 1924

Belgian zinc smelters hope to replace the losses in their intake as a consequence of the suspension of Australian shipments—due to failure of British Board of Trade to renew contracts—by receipts from British Columbia, the Coeur d'Alenes and Mexico.

Directors' report on 1924 operations of Vieille-Montagne, Belgium's largest zinc smelting and rolling company, says that nation's output has increased from 148,080 tons in 1923 to 162,990 in 1924, but is still below the 1913 figure of 194,560 tons. Nevertheless, Belgium is second in list of producing nations, having passed Germany, being now exceeded only by the United States. After devastation caused by the war, development of plants in Belgium and France has been rapid.

The following table shows Vieille-Montagne zinc output in metric tons of 2,204.6 lb. each:

1913	104,265	1923	73,000
1921	39,865	1924	85,000
1922	63,464		

The company has smelting furnaces and rolling mills in Belgium, France, England and mines in Algeria, Tunis and Spain. Representatives have been in Mexico, British Columbia, and the United States to study sources of concentrate.

Net profits for Vieille-Montagne have increased from 15,814,000 francs in 1922 to 26,647,000 francs in 1924. During 1924 the capital was increased to 12,000,000 francs from 9,000,000.

Ahumada Low-Grade Ore Successfully Concentrated at Ajo

A concentrator probably will be built by the Ahumada Lead Co. at its property in Los Lamentos district, Chihuahua. There has been developed about 500,000 tons of low-grade ores in connection with the high-grade ore in the mine. Until recently this class of ore was considered to be of little value. Tests made in the experimental mill at the New Cornelia property at Ajo, Ariz., indicate that these low-grade lead ores can be successfully treated. A 10 per cent ore can be readily concentrated to 30 per cent, and an 18 per cent to 50 per cent, with a recovery of 90 per cent. The ores contain some gypsum that causes a foam, but this difficulty has been overcome. This ore is very friable and a ball mill will handle, it is believed, about 900 tons a day.

The winze recently sunk at the end of one of the lead-bearing caves followed the ore downward more than 200 ft. At the bottom of this winze the ore was richer than at any point above, both in lead and silver, showing about 40 per cent lead and about 6 oz. silver.

Quicksilver Production in California 700 Flasks Per Month

The rate of quicksilver production in the United States is now slightly more than 10,000 flasks per annum. California, Texas, and Nevada are the important producing states. California is producing more than 700 flasks per month, Texas about 125 and Nevada from 50 to 60 flasks. Production in California is coming from New Idria, New Almaden, Cloverdale, Knoxville, and Paloma. The Helena and Etna mines are being worked, but have not reached production; the same is true of the Cuddeback property near Tehachapi. Activity in quicksilver mining shows a slight increase. During the last year and a half fifteen quicksilver properties have changed ownership. The Guadaloupe, in Santa Clara County, has been sold and will probably be producing in the near future. The details of the sale have not been made public.

Dunwell Mines Gets Good Assays in New Sunbeam Claim

According to a statement issued by Dunwell Mines, the new discovery on the Sunbeam claim in the Portland Canal district in British Columbia has been traced for 555 ft. by a series of open cuts. Assays of average samples from the first three cuts give the following results: 1 ft. of ore gave 0.15 oz. gold and 238.7 oz. silver; 1 ft. of ore gave 0.17 oz. gold and 274.4 oz. silver; 2 ft. of ore gave 0.33 oz. gold and 270 oz. silver. Sufficient exploration has not been done as yet to determine whether this vein is the northern extension of the main Dunwell vein, the main workings of which are about 1,000 ft. away from the nearest opening on the new discovery. However, it is planned to continue work energetically in order to reveal the possibilities.

Copper Stocks on July 1 Lowest Since War

STOCKS OF COPPER in the hands of American producers, according to estimates circulating in the industry, totaled only 85,000 tons on July 1. This is the lowest figure at the end of any quarter since the war. The previous low mark was reached on July 1, 1923, when stocks totaled 98,850 tons, whereas the figure for April 1, 1925, was 122,398 tons.

North and South American producers shipped during the second quarter about 365,000 tons of the metal, contrasted with 341,800 in the first quarter, and the previous record quarterly shipments of 363,350 in the first quarter of 1924.

Production of refined copper, including Lake, for the second quarter, is estimated at 330,000 tons, against 327,720 tons in the first three months.

The copper on hand at the beginning of July is equivalent to about twenty days' shipments by North and South American producers at the present rate.

Shipments estimated at an average of 121,500 tons a month for North and South American producers would indicate a world consumption of copper during the second quarter of 1925, it is estimated, approximating 150,000 tons a month, the highest in the history of the industry.

Moore Mining Co. Plans Improvements

The Moore Mining Co., of Jackson, Calif., control of which was acquired recently by F. H. Rindge, of Stockton, Calif., for $150,000, will spend the money to install a double-drum hoist, purchased several months ago; to complete the present shaft to three compartments to a depth of 1,250 ft.; to develop the Moore vein northwesterly drift; to drive a southeasterly drift in the Zeila vein; to sink the main shaft an additional 600 ft., and to crosscut on the lowest level for new veins. The present management remains unchanged. Options have been taken on adjoining lands, including the South Jackson properties, just north of the Moore holdings.

Primos Chemical Co. Gets Control of Bay Horse

The sale of control in the Bay Horse mine, nine miles from Huntington, Ore., to the Primos Chemical Company of Philadelphia, was authorized by the stockholders of the U. S. Metals Co. at a special meeting held in Spokane.

The purchaser will take 60 per cent of the stock and in return agrees to perform ninety shifts of work a month for the first ninety days in driving the lower tunnel, which is reported to be near ore.

The first payment, which will be $22,000, is to be used in the liquidation of a mortgage on the mine, according to J. L. Magney, a director. The remainder of the $250,000 will be used in the installation of a mill and the development of the mine. If there is a surplus it will be placed in the treasury of the U. S. Metals Co.

To facilitate the transfer of a 60 per cent interest, the capitalization of the U. S. Metals Co. was increased from 3,000,000 to 7,500,000 shares, as authorized at a meeting a year or two ago. The 4,500,000 new shares will go to the Primos people and the remainder will remain with the present stockholders, it is stated.

Utah's Metal Output for 60 Years $1,358,738,044

The total value of gold, silver, copper, lead and zinc produced from Utah mines from 1864 up to the beginning of the present year amounts to $1,358,738,044, according to figures compiled by the U. S. Geological Survey. The value of these metals produced in 1924, amounting $66,227,637, was slightly lower than that of 1923, owing to the lower silver prices.

Figures show that a total of 107,681,084.71 oz. of gold, 489,284,791 oz. of silver, 5,272,601,429 lb. of lead, 269,357,867 lb. of zinc, and 3,245,345,650 lb. of copper have been taken from Utah metal mines from 1864 up to 1925.

Despite this remarkable record, Utah mines at present are producing a larger amount of non-ferrous metals than at any time in past history, and many are looking to 1925 as a banner year.

The output of gold, silver, copper, lead, and recoverable zinc during 1924 in Utah is shown by counties in the following compilation by V. C. Heikes, statistician of the U. S. Geological Survey. Output of all metals except gold and silver shows an increase.

Utah Metal Output During 1924

County	No. Producers	Ore treated, tons	Gold oz.	Silver oz.	Copper lb.	Lead lb.	Recoverable zinc lb.	Total value
Beaver	8	14,297	673.09	105,671	61,308	2,589,376	40,201	$302,508
Boxelder	3	70	15.57	542	67	13,165	.....	1,747
Garfield	2	4	9.19	1	.....	.....	.....	191
Iron	1	23	.....	26	66	11,433	.....	941
Juab	26	232,301	24,602.36	4,285,995	2,486,716	35,079,039	162,138	6,516,265
Piute	2	146	367.41	809	2,091	2,613	.....	8,620
Salt Lake	36	12,725,281	102,653.01	2,917,212	236,432,895	75,847,732	11,477,212	41,864,444
San Juan	1	32	27.17	7	.....	.....	.....	567
Summit	8	273,269	5,036.42	3,343,811	1,306,378	50,863,177	2,535,772	6,749,480
Tooele	29	90,885	826.92	331,989	403,093	6,615,007	22,860	823,018
Utah	16	165,797	4,729.82	3,995,901	717,023	47,059,779	72,957	6,638,482
Wasatch	5	138,523	7,540.79	2,269,729	778,528	15,829,563	4,251,032	3,321,268
Wayne	1	.....	5.08	1	.....	.....	.....	106
Total, 1924	150	12,752,998	148,824.86	19,137,470	222,138,163	233,910,875	18,562,172	$66,227,637
Total, 1923	138	13,640,618	146,486.85	17,253,692	242,373,572	203,447,793	11,330,913	66,472,911

News From Washington

By PAUL WOOTON
Special Correspondent

Bureau of Mines Transfer Accomplished Without Fuss

"Carry On," Says Judge Davis to D. A. Lyon—Mineral Resources and Statistics Division Also Changes Allegiance to Commerce

NO FORMALITIES surrounded the transfer of the Bureau of Mines from the Interior Department to the Department of Commerce on July 1. Dorsey A. Lyon, the acting director, on that day was an early caller at the office of the Secretary of Commerce, where Judge S. B. Davis, the department's solicitor, is holding forth in the absence of Secretary Hoover and Assistant Secretary Drake. Judge Davis informed Dr. Lyon that he had no instructions to give him, other than to state that he was to continue his work just as he would have done had the transfer not taken place. Judge Davis affixed his signature to the documents that require the approval of the Secretary at the beginning of the fiscal year, and the Bureau of Mines became an integral part of the Department of Commerce.

The transfer of the Mineral Resources Division of the Geological Survey to the Bureau of Mines was accompanied by an informal assembly of the personnel of the Mineral Resources Division in the meeting room of the Bureau of Mines, where F. J. Katz, the head of the division, introduced each member of his staff to Dr. Lyon. Dr. Lyon welcomed them into the bureau. He expressed the opinion that the breaking of the immediate ties with their associates in the Geological Survey naturally was a matter of regret to them, but he gave it as his opinion that they would find just as worth-while friends among the members of the Bureau of Mines, so that they would gain rather than lose, as there is going to be no interruption in the very close contacts between the two bureaus. He also expressed the thought that their work might become even more interesting, as the division is made up of those accustomed to deal with economic phases of the industry, which now is to be emphasized as much as possible.

Mr. Katz, on behalf of the members of his division, assured Dr. Lyon that he might count upon the same degree of loyalty which they always had given the Geological Survey. He declared that the division is proud of its record, which has been made possible only through the hearty co-operation of every member of the staff, and that all are determined to maintain the standard which they have built up.

In the Bureau of Mines the title of the division will be that of "Mineral Resources and Statistics." Mr. Katz will report directly to the assistant to the director. This classification of the new division is a temporary one. There is no desire to make it permanent until the views of Secretary Hoover's advisory committee can be obtained.

Due to the absence of Secretary Hoover, there has been some delay in launching the work of the advisory committee, of which J. V. W. Reynders, the president of the American Institute of Mining and Metallurgical Engineers, is chairman. Secretary Hoover before leaving Washington had expressed the desire that the committee be representative of the organizations immediately concerned with the work of the Bureau of Mines. After his departure an analysis of such organizations developed a long list. Representations were made on behalf of several organizations to the effect that they should be recognized in that connection. This situation has presented something of a problem. Mr. Hoover's assistants recognize that he wants the committee to be broadly representative of the industries concerned, but at the same time they are faced with the necessity of preventing an expansion of membership to the point where the committee would be unwieldy. Those difficulties, however, are about to be ironed out, as this is written, and a call for a meeting is imminent. It is recognized as being highly desirable for the committee to be working in the absence of Secretary Hoover, so that its perfected recommendations may be laid before him on his return about Aug. 1.

The American Mining Congress has named L. S. Cates, its president, as its representative on the committee. James F. Callbreath, the secretary of the Congress, has been designated as his alternate. The National Coal Association has named J. B. Bradley to serve on the committee, while the United Mine Workers have selected Philip Murray. H. Foster Bain also is to be a member of the committee because of his intimate knowledge of the bureau's work. As this is written, the other organizations that will be asked to designate members of the committee have not been determined upon finally.

Ebenstein Mill Burns; Euterpe Finishes Reconstruction

The Ebenstein mill of the Chanute Spelter Co., located near Baxter Springs, Kan., in the Joplin-Miami field, was destroyed by fire on the evening of June 20. It was a 300-ton plant, valued at $60,000, and had not been in operation for several months. It was electrically equipped throughout. The Chanute Spelter Co. is a subsidiary of the American Metal Co.

The Euterpe Mining Co. has completed its third mill on its lease near Baxter Springs, Kan., in the Joplin-Miami district. Its two other mills, on the same lease, were lost by fire. The mine was rapidly becoming a fine producer when the last fire occurred. O. A. Weaver, of Joplin, is superintendent.

Sharp Curtailment in Joplin-Miami Zinc-Lead Field

CURTAILMENT of output in the Joplin-Miami zinc and lead district on account of the Fourth of July holiday was greater this year than in most years, amounting, according to estimates, to about 5,000 tons for the week ended July 4 and 8,000 tons the succeeding week.

Most of the mines closed down Thursday, July 2, or Friday, July 3, and while some of them started up again on Monday, July 6, many remained down for a week and some longer yet.

The O. M. Bilharz Mining Co. closed its three mines July 2 and will not reopen them until August 1. The Eagle-Picher Lead Co., the Consolidated L. & Z. Co., and the Underwriters Land Co. planned to keep their twenty-five properties idle until July 13. The Federal Mining & Smelting Co., the Vinegar Hill Zinc Co., the Admiralty Zinc Co., and the Golden Rod M. & S. Co., all heavy producers, planned to close for an entire week.

Growing Activity in Non-Metallics in Southern California

Los Angeles is becoming quite a ceramic center, F. J. Katz, head of the Mineral Resources Division of the U. S. Geological Survey reports on his return from a visit to the Western offices of the Survey. As a result the production of non-metals is being stimulated in southern California.

Several factors are operating, Mr. Katz says, to build up a market for the non-metallics in southern California. High freight rates more than any other thing are tending to build up local manufacturing. The growing population now offers a broad market. Both electric power and fuel oil are cheap.

Mansfeld, German Copper Producing Company, Lost in 1924

The Mansfeld Aktien Gesellschaft, of Eisleben, Germany, leading producer of copper from native ores, has reported a loss of 2,721,945 reichmarks (approximately $680,000) from operations in 1924. This enterprise had the drawbacks common to German industry generally, and also the falling price of copper. Plans to shut down the copper mines were abandoned upon the receipt of a state loan, and at the end of the year business improved.

Production in 1924 increased over 1923, but the 1923 record was abnormally small in consequence of indirect results of the Ruhr occupation, although the Mansfeld plants were not in occupied territory. The 1924 production of refined copper (some from imported ores) amounted to 21,423 metric tons, and silver production was 91,381 kilos; the 1923 totals were 17,124 tons and 70,436 kilos respectively.

London Letter

By W. A. Doman
Special Correspondent

West Rand Consolidated Finds Good Ore in West Area

Better Than Average of Reserves—Hope to Start Lena and Sissert Operations in Russia

London, June 23—About one-half of the 2,000-odd claims of the West Rand Consolidated lie to the west of the big dike that traverses the property diagonally from northeast to southwest. Hitherto this big western area was considered to be almost valueless, developments in the upper levels of the western shaft (sunk to the west of the dike) having failed to disclose payable values. A year or two ago a program of more extensive exploration in the eastern shaft was inaugurated and the reef at depth was found to be more regular, wider and richer than nearer the surface. Consequently it was decided to deepen the western shaft, and the decision of the management appears now to have been fully justified, for the latest news is to the effect that at the twentieth or lowest level the 340 ft. driven averages 12.7 dwt. over 64 in. This compares with an average of 5.8 dwt. over 50 in. for the whole of the ore reserves. The manager, C. S. McLean, who two years ago took over the post from G. D. Stephen (now at the Van Ryn), has had an uphill task and his success has probably doubled the life of the mine.

Apparently a serious attempt is being made to restart operations on the mining properties in Russia belonging to the Lena Goldfields and the Sissert company. It may be remembered that an agreement was entered into for the consolidation and control of the mining enterprises of these two concerns as well as of certain other properties, on the basis of an exchange of shares. The Lena is to increase its capital from £1,405,000 to £4,600,000. The Sissert property contains forests, copper, gold and iron mines, collieries, iron works, plant, etc., and production on a large scale had been attained in pre-war years. This estate will be taken over and operated by the Lena, presumably under the direction of A. P. Malozemoff, who is technical adviser to the company. Sissert shareholders receive share for share and pay the expenses incidental to the carrying out of the scheme.

No one probably knows more about the diamond industry than Ernest Oppenheimer, the chairman of the Anglo-American Corporation, and his explanation of the conditions that led up to the break with the London Diamond Syndicate is very interesting. The agreement between the four big diamond producers of the Union and the London Syndicate terminated at the end of 1924, and as the latter refused the offer of the former for a renewal of the agreement, negotiations were broken off. The Anglo-American Corporation then made an offer on the terms demanded by the Union producers to the Diamond Mines of Southwest Africa for the purchasing of its output and, at the same time, extended the offer to the De Beers and Premier companies. The Southwest Africa company accepted, but the others did not. Afterward the remaining members of the syndicate purchased the Union production, possibly on better terms from the producers' point of view than those offered by the Anglo-American.

In view of the mineral possibilities of British Guiana, it is interesting to note that H. G. Cobbe, who represented that colony at Wembley, where a diamond-washing plant was on view, has just left for Georgetown en route for the mining field. I understand his mission is to inspect a gold-mining proposition.

Silver King Will Add to Flotation Equipment

PRELIMINARY work for the construction of an additional 500-ton flotation unit at the concentrator of the Silver King Coalition Co., at Park City, Utah, has been completed. The new plant will be built of steel and concrete and when completed will represent an investment of approximately $75,000. Considerable significance is attached to the announcement, owing to the large amount of second-class ore the Silver King is producing—aside from its large high-grade production.

The new unit will include also a fine-grinding plant, which is expected to be put in operation in October.

The company decided on the new plant after many months of experiment and a material improvement in net recovery is expected.

German Metal Consumption Shows Large Gain in 1925

Germany's non-ferrous metals consumption thus far in 1925 has increased enormously compared with last year, according to W. T. Daugherty, trade commissioner at Berlin. The local electrical industry is well employed, cable works have large orders from the postal administration, accumulators works are busy, although there is marked falling off in activity of the rolling mills and galvanizing plants. Sales of the metal futures on the bourses, which opened April 20 in Berlin and Hamburg, have not been up to expectation, however.

The increased consumption is indicated by the following import figures for the first quarters of 1924 and 1925:

Metal	First Quarter 1924 (Metric Tons)	First Quarter 1925 (Metric Tons)
Copper	12,282	57,498
Lead	4,481	40,669
Zinc	6,875	29,814
Tin	1,713	3,540
Aluminum	855	2,814
Nickel	105	851
Antimony	223	738
Silver	23	300

Out of copper imports in the first quarter of 1925, 47,585 tons, or 82 per cent, originated in the United States; lead, 13,290 tons, or 32 per cent; zinc, 4,768, or 16 per cent; tin, 200, or 6 per cent; nickel, 34, or 4 per cent.

Toronto Letter

By Our Special Correspondent for Northern Ontario

J. H. Stovel, New Manager, Will Push "W A D" Development

Shaft to Go to 400 Ft.—New Finds in South Lorrain—Nipissing Dividend Only 3 Per Cent

Toronto, July 3—The Messrs. Wentworth, Anderson and Davis, of the "W A D" syndicate of northern Manitoba, are visiting the company's properties; they are accompanied by A. D. Miles, of the Anglo-Canadian Explorers, which is an exploration company for John Taylor & Sons, of London. An arrangement has recently been completed whereby the Anglo-Canadian Explorers will gradually acquire a half interest in the Central Manitoba group of the "W A D" holdings and will participate in the development of the other properties owned by the syndicate. J. H. Stovel, superintendent of the mining division for E. J. Longyear & Co., has been appointed manager of the "W A D" property to succeed the late N. H. Emmons, 2d. The shaft on the central Manitoba group is now down 200 ft. and will be continued to a depth of 400 ft. Diamond drilling is also being carried on, and although no official statement has been made, it is understood that results have been very satisfactory.

The Mining Corporation has recently made several new discoveries on its South Lorrain property, where veins varying up to 18 in. in width and carrying ore up to 3,000 oz. of silver have been found. New discoveries have also been made on the Cobalt Lake property in Cobalt. Several veins showing high-grade ore have been found. Very little work has been done on them as yet, but they are of interest not only to the Mining Corporation but also to the McKinley property adjoining, as it is probable that some of these veins will be found on the McKinley ground.

The McKinley has also made two new discoveries on its own property, one on the 350 level showing 2 in. of 8,000-oz. silver ore and another on the 75 level showing 2 in. of 5,000-oz. ore. The company is developing an interesting section of the property that has been explored to only a limited extent. While the area is not large, it does not require much acreage in the Cobalt district to produce substantial quantities of silver. On the Princess property, adjoining the McKinley, which consisted of seventeen acres, only a portion of which was mineral bearing, the total production was about 6,000,000 oz. The Coniagas produced more than 30,000,000 oz. from a single forty-acre claim and on the original LaRose claim, more than 17,000,000 oz. came from a very few acres.

The Nipissing Mining Co. has declared the regular quarterly dividend of 3 per cent, payable July 20. It is now apparent that the company does not purpose to continue the bonuses that were formerly paid and that amounted to 6 per cent for the year. It is understood that earnings are now only a little more than the regular dividend requirements.

Situation at the Mines

By Arthur B. Parsons
Assistant Editor

CURTAILMENT in production of zinc, copper, and iron and, to a less extent, of lead, is the feature of the current situation in the metal-mining industry. On the other hand, exploration, prospecting, and development are unusually active; and with satisfactory smelter returns based on reasonably high metal quotations, miners of the non-ferrous metals are fairly prosperous. Iron mining is depressed by a low price and limited demand. Copper at 13⅝c. does not spell dividends for all the companies that are producing today, but that figure, as indicated in the accompanying table, is better than at any time since March. Zinc, likewise, shows a slight improvement over the last few months. Lead and silver were higher in June than in May, but lead has not been returning the producer of ore quite as much so far in July. Still, there is no complaint voiced at 8c. lead and 69c. silver.

Average Metal Prices

Period	Copper	Lead	Zinc	Silver
February	14.463	9.428	7.480	68.472
March	14.004	8.914	7.319	67.808
April	13.252	8.005	6.985	66.899
May	13.347	7.985	6.951	67.580
June	13.399	8.321	6.99	69.106
July (first week)	13.643	8.055	7.083	69.300

Labor—The labor supply seems adequate, the only complaint being a mild one from Arizona, where more good underground workers, both Mexican and American, could find employment. There have been no recent changes in wage scales, nor agitation for increases. Ordinarily the arrival of summer gives rise to an exodus of workers from the mining camps, with a consequent cry of shortage. That such a situation seems not to have materialized this year may be accounted for partly by the existing depression in other industries that offer opportunity for the class of men who work in the mines, and partly by the constant improvement in working conditions in the mines. Mechanical ventilation, in particular, has been given increasing attention, and this lessens the urge of the miner to get out on a fresh-air job during the summer. Still a third factor is the growing use of mechanical devices for handling ore; not so many men are required to produce a given tonnage.

Copper—How much further the purported reductions in rates of copper production will affect aggregate output is hard to say. At any rate, the estimated mine output for the United States during May was 5,000 tons less than that of March, and a reduction of 10,000 tons in the world production of blister copper in the same period is estimated by the American Bureau of Metal Statistics. Expected reductions by the Phelps Dodge Corporation materialized neither at Moctezuma nor in Arizona during June. Calumet & Arizona, and New Cornelia, between them, cut by about 500 tons, and Old Dominion output was materially lower than in May. The Iron Cap Copper Co. has shut down its concentrator at Globe, Ariz., and will confine production to direct smelting ore.

In Michigan, on the other hand, the total production of 6,650 tons is 425 tons above the May record. Calumet & Hecla accounted for most of the increase, in part from its new Tamarack reclamation plant, where low-cost copper is made. As was anticipated, the production of the Union Minière is being augmented as a consequence of the coming of the dry season, which facilitates operations in the Belgian Congo tropics. Mt. Morgan, in Australia, is contributing to production 500 tons per month, much more than in the early months of the year. Everything points to the conclusion that Anaconda and the companies it dominates are carrying out the announced plan of cutting drastically the high production rates of the first quarter of the year, when the Butte mines were outputting about 11,750 tons monthly. The Mason Valley copper smelter at Wabuska, Nev., is to be blown in as soon as the mine and mill are in regular operation. A second unit to the Granby concentrator at Anyox, B. C., is planned for early erection.

Zinc—Zinc-lead producers in the Joplin-Miami district in recent years have observed the Fourth of July season fittingly by declaring their independence of the ore buyers. This has manifested itself in the shutting down of mines, a move calculated to decrease the stock of "jack" at the concentrators and improve the price. This year most of the mines have suspended for at least a week and many for a two-week period. A net "loss" in production of about 15,000 tons is expected. On resumption, about 150 plants will be in operation, making about 14,000 tons of zinc concentrate per week, compared with 18,000, the maximum reached during early part of the year. The value of zinc and lead concentrate shipped from the district up to July 1 was $27,400,000. If the rate is maintained during the second half of the year, the high record of $41,000,000, made in 1924, will be surpassed by $13,000,000.

In the Rocky Mountain region production of zinc ore from several small properties is increasing. Although these activities do not have any great effect on the gross current production, they indicate the growing interest in zinc and "complex" ore mining. The plant of the Combined Metals Co., at Bauer, Utah, is making 1,500 tons per month of zinc concentrate and leached zinc-bearing residue from Pioche, Nev., ores; the Midvale concentrator of the United States S. R. & M. Co.—where, incidentally, a new $750,000 zinc plant is being erected—is turning out an equivalent amount; and from its Tooele plant the International Smelting Co. is said to produce 5,000 tons of concentrate per month from ores from Park City and one or two Colorado camps.

Lead—The lessening of the lead production rate arises as an incident to the curtailment of zinc mining in the Joplin-Miami district and from some reduction in rates by small producers elsewhere. At the same time new lead-mining activities are reported in the far West. The Acme Mining Co. is said to be developing good lead ore in the Darwin district in California, and in Nevada the Chalk Mountain Silver Lead Mines Co. has shipped eighteen cars of $90 ore. The Lead-ore Mining Co., operating in Lemhi County, Idaho, will increase the capacity of its plant from 50 to 150 tons per day. A new flotation plant has been put in operation by the Sheldon Mining Co. at Walker, Ariz.; the Ahumada Lead Co., of Chihuahua, has developed a process for treating its low-grade ores and probably will erect a concentrator to treat large reserves of second-class ore. An excellent showing of lead-silver-zinc ore similar to that in the neighboring Sullivan mine of the Consolidated M. & S. Co. has been opened in the Stemwinder mine in British Columbia.

Silver—There is small change in the world rate of silver production. Developments in northern Ontario are favorable. In the South Lorrain area discoveries in the Frontier property have been particularly promising; new orebodies are reported in the Walsh property of the Tonopah Mining Co. at Gowganda, and at Cobalt there are first class showings in the new Nipissing shaft and in the McKinley-Darragh mine. Utah silver camps are flourishing. A new flotation unit is to be added to the Silver King Coalition concentrator at Park City, and in the same camp a new aërial tram is to be built from the Judge mill to the railroad. Production from the Tintic district is at a high rate and exploration is active. Silver output in Tonopah is recovering slowly from the effects of the sharp curtailment by the Tonopah Extension. The Primos Chemical Co. has acquired control of the Bay Horse silver mine near Huntington, Ore., and will build a mill.

Gold—Gold production in northern Ontario continues its upward swing, the total output for June, estimated at $2,650,000, being another new record. In California the Argonaut finally has closed the deal whereby it obtains the Plymouth mine, and is now operating it. A transaction that may develop into something of importance is the bonding of two groups of claims in the Fairview district, of Nevada, by F. W. Bradley and associates.

Iron—Early estimates of ore shipments from the Lake Superior iron-mining region have been reduced to 50,000,000 tons for the current season. Although this is 7,000,000 tons above the record of 1924, independent producers are facing an 80c. cut in the price of ore, and are earning very little or nothing.

Societies, Addresses, and Reports

Explorations in Northern Alaska Continued

Search for Oil Goes On in Naval Petroleum Reserve No. 4—Further Word Expected in September

A two-months old letter sent from Kotzebue, Alaska, by Gerald FitzGerald, in charge of the geologic and topographic party that left Washington last February to continue surveys in Naval Petroleum Reserve No. 4 in northern Alaska, has just been received by the U. S. Geological Survey. This letter, dated April 10, is a mute witness to the remoteness of the region from which it came.

The party made the trip from Nenana, on the Alaska Railroad, to Kotzebue, a distance of about 700 miles, by dog teams in twenty-seven days. In spite of storms and bad weather, they were on the trail every day except one, so that the average daily run was more than twenty-five miles, and, according to Mr. FitzGerald, on one day they made a run of forty-seven miles.

Kotzebue is a little settlement on the eastern shore of Kotzebue Sound, a short distance north of the Arctic Circle, and its white population usually consists of a trader, a missionary, a school teacher, and at most possibly half a score of others. It is near the mouth of Noatak River, one of the large streams that flow from the region far back in the mountains of northern Alaska. This river is the route the surveyors followed in going into the naval petroleum reserve.

Mr. FitzGerald and party planned to go up the Noatak and one of its tributaries, the Kugururok, 150 to 200 miles to find a pass across the Brooks Range, which forms the northern divide of the Noatak basin. On the north side of the range is the headwater region of Utukok River or some other stream that flows northward into the Arctic Ocean. The party was probably well across the mountains before the spring break-up of the ice, which in this region usually happens between May 15 and 25. The explorers carried with them enough supplies of food and equipment to last them the next five months, while they are working in the reserve. These supplies made a load of nearly two tons in addition to a canoe, which the party will use during the open season in traversing the streams of the region.

As the party will be entirely out of reach of communication until September, probably nothing further will be heard from them until they return in the fall. In fact, it is doubtful whether they will even see any natives after they leave Noatak River until they approach the coast in September. Besides mapping geologically and topographically several thousand miles of hitherto unsurveyed or unexplored country, they should add materially to the knowledge not only of the immediate problem with which they are principally concerned—the search for petroleum—but also of the general features of a tract of country probably as large as the State of Massachusetts, into which, so far as the Survey records show, no white man has ever stepped.

The party was thoroughly equipped to meet all the conditions that can be anticipated, and the leader is especially conversant with the country and the conditions of work, for this is his third trip into the naval petroleum reserve, and he has also served several years as a member of the Geological Survey in Alaska and the United States.

W. R. Smith, the geologist of the party, is a graduate of Johns Hopkins University, and although this is his first year north of the Arctic Circle, he has served several years on the Survey in examining and reporting on the possible presence of petroleum in parts of the Alaska Peninsula.

W. R. Blankenship, who was with the Survey parties in the naval petroleum reserve in 1924, and F. E. Delzene, one of the champion dog drivers of Seward Peninsula, are with the party as camp assistants. Probably one or more Eskimos and their dog teams were hired at Kotzebue or at the mission on the lower Noatak to assist the party in freighting supplies to the place where the real work of surveying new country was started.

Aid for Mineral Development in South Africa Proposed

In spite of the great value of South Africa's present mineral production, it is believed that with the stimulation of production, the removal of obstacles to exploitation and development, and the greater utilization of the Union's raw mineral wealth through local manufacture, the mineral output could be greatly increased. This is the opinion of a committee of government experts who have been studying for the past year these aspects of the mining industry and its resources, according to the trade commissioner at Johannesburg.

Up to date only gold, diamonds, cement materials, copper, and tin have been extensively exploited. Partial or intermittent exploitation has been devoted to a long list of products, including antimony, arsenic, asbestos, clays, corundum, glass sand, lead, magnesite, manganese, marble, mineral ocher and paints, ornamental stones, phosphates, soda, sulphur (pyrite), talc and vanadium. So far silver, mercury, tungsten, and some other minerals have been discovered only in negligible quantities, if at all.

The committee has recommended that the government should continue to organize assistance through the identification of rocks and minerals, cheap assays and analyses, geological information and advice, and larger appropriations for general mineral investigation. Direct financial investment or aid is not considered necessary, nor is financial help to prospectors. It advises, rather, that the state should aid by promoting such basic conditions as will stimulate the investment of private capital, which should in the early and costly development period be free from taxation on supplies and equipment, either by tariffs or freight rates. Indirect assistance of several types is also recommended, such as low freight rates, both rail and ocean, bounties, protective tariffs, and publicity.

In addition, the committee has given consideration to the removal of existant obstacles that now hamper the expansion of mineral development, and recommends that the laws now governing land owners and prospectors in the Transvaal should be altered so as to permit free prospecting under adequate safeguards, and that claim licenses should also be revised. Another serious obstacle to mineral development is that in all grants of government land issued since 1903, and even in many issued prior to that year, the mineral rights are reserved to the crown. As a result, on about 5,400,000 acres the rights have been locked up between 1912 and 1920. Marketing problems are often an obstacle, while the attraction of capital for investment could be improved through alteration of taxation. The lack of roads, organization among producers, and adequate information were also discussed in the report.

At present the domestic consumption of minerals produced in South Africa is limited, but is capable of expansion principally through government purchases and the establishment of branch factories of oversea enterprises. The gold industry and the distillation of oil shale are put forward as presenting promising fields for domestic industrial development in view of their outstanding importance, both actual and potential.

How far this large program will be embarked upon by the government cannot be forecast. At the same time, the report has served to focus attention upon the fundamental importance to South Africa of her abundant mineral resources and the necessity for their further development.

Western Australia Studying Gold Mining

The State Government of Western Australia, on coming into power, announced its intention of appointing a royal commission to investigate and report on the conditions now in operation for mining and treatment of gold ores and on various other subjects cognate to the industry. Charles Kingsley Thomas, a mining engineer, late of South Africa, has been appointed royal commissioner and he is now engaged in investigating the problems on which he is to report.

Mining Congress to Issue News Letter

The American Mining Congress has established a biweekly news letter which it will send to such periodicals as desire it. In this it will give mining news from Washington, particularly as to the activities of its own organization. It is said that it will not be a propaganda service.

Men You Should Know About

Dwight E. Woodbridge, of Duluth, has spent the past two weeks in Detroit on iron ore business.

E. O. Ulrich, of the U. S. Geological Survey, is in Europe to make a study of the Paleozoic sections.

George F. Stott has succeeded **R. E. Wadleigh** as superintendent of the Holly Consolidated at Eureka, Nev.

Hans Lundberg, field manager for the Swedish American Prospecting Corporation, has been visiting southern California, Arizona, and Texas.

W. E. Defty, of Phoenix, Ariz., will be in Canada for a couple of months. His address during July and August will be Victoria, B. C., Canada.

John L. Bray, professor of metallurgy at Purdue University, is engaged in a study of Indiana coals for the Engineering Experiment Station.

Dr. Roy Cross and **Dr. Walter Cross** of the Kansas City Testing Laboratory are now connected with the Industrial Testing Laboratory of Los Angeles, Calif.

Jules Labarthe, metallurgical engineer, of San Francisco, recently returned from a trip to Mexico City, where he looked into certain smelting problems in connection with the treatment of Mexican ores.

Martin Schwerin, of Tucson, Ariz., returned to Tucson from Costa Rica, via New York, after having examined the Aguacate mines of Costa Rica, Central America.

N. H. Getchell, general manager of the Betty O'Neal mines at Battle Mountain, Nev., has returned to the mine from a trip into Arizona and southern California.

J. B. Mertie, Jr., and his Geological Survey party have started down the Yukon River from Dawson to make geologic examinations in the vicinity of the international boundary.

William Porri, formerly manager of the New Dominion Copper Company, at Globe, Ariz., is leaving for Alamos, Sonora, Mexico, where he will manage the properties of the Alamos Silver Mining Co.

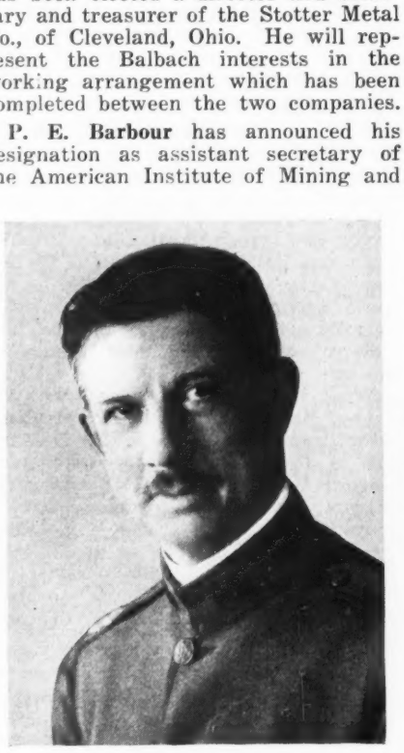
Hugh Rose, managing director of the Goldfields American Development Co., Ltd., of which the Comstock Merger at Virginia City, Nev., is a subsidiary, was recently in Virginia City from his Mexican headquarters.

C. H. Abeling, construction engineer and metallurgist, has completed the reconstruction of the Tetreault mill, in Porteneuf County, Quebec, for the British Metal Corporation (Canada), Ltd., and has accepted the position of mill superintendent with the California Zinc Co., at Winthrop, Calif.

Edward H. Orser, consulting mining engineer and geologist, 509 Federal Building, Toronto, Ont., is engaged in making an extensive examination of the property of the Abitibi Mines, Ltd., in the Lighting River area, with a view toward planning a thorough program of exploration this year.

James MacNee, Jr., of the Balbach Smelting & Refining Co., Newark, N. J., has been elected a director and secretary and treasurer of the Stotter Metal Co., of Cleveland, Ohio. He will represent the Balbach interests in the working arrangement which has been completed between the two companies.

P. E. Barbour has announced his resignation as assistant secretary of the American Institute of Mining and Metallurgical Engineers and as editor of *Mining and Metallurgy.*



Colonel Percy E. Barbour

G. R. Lyman, general sales manager of the Taylor-Wharton Iron & Steel Co., has resigned, effective May first. **G. R. Hanks,** formerly superintendent of the High Bridge plant of this company, has been appointed assistant to the president, with full charge of all sales. **Stanley Apgar** has been appointed plant superintendent.

G. C. Klugg, of Bewick, Moreing & Co., who has been closely connected with Western Australian, Broken Hill, and Queensland mining and metallurgical interests, was in March and April last visiting various mining centers of the Australian Commonwealth. Mr. Klugg's headquarters are in London, whither he returned in May.

W. W. Jourdin, chief electrical engineer for the Inspiration Consolidated Copper Co., has returned to Miami, Ariz., after a stay of several months in New York City, where he has been engaged in designing new equipment for the Andes Copper Co., which is spending approximately $40,000,000 on new construction at its property in South America.

In this column in the issue of July 4, in relation to a visit by **Thomas J. Ryder** and **E. DeGolyer,** of the Rycade Oil Corporation, to the company's holdings in the Gulf Coastal territory, it was stated that the Rycade was a subsidiary of the Dutch Shell. That was an error. The Rycade is not a subsidiary or in any way affiliated with the Dutch Shell interests.

R. E. Hanley, who has been superintendent of the Mammoth mine, has succeeded **O. J. Egleston,** of the Mammoth Copper Co., as general manager. Mr. Egleston has been transferred to Nome, Alaska, where he will be in charge of certain work in the new dredging interests of the U. S. Smelting Co. **John Preichler,** chief accountant of the Mammoth Copper Co., will also be stationed at Nome.

Alexander Anderson, of Fullerton, Calif., is operating several new devices for obtaining data on underground conditions in the deep oil wells of that state. Mr. Anderson's inventions include apparatus for accurately surveying the underground course of oil wells and apparatus and methods for taking oriented core samples at the bottom of a rotary hole. Another branch of his work is a new method of handling impression blocks and fishing tools in oil wells.

For the first time in many years, a mining man has been appointed to the Michigan State Tax Commission. The new member is **Charles H. Baxter,** of Loretto, on the Menominee iron range. He was appointed by Governor Groesbeck for a term of two years at an annual salary of $5,000. Mr. Baxter, a graduate of the Michigan College of Mines, is well known throughout the mining districts of Michigan. He has been mine superintendent of the Loretto property for a number of years and for the past sixteen years has served as a member of the Dickinson county board of supervisors.

Douglas Lay has been appointed resident mining engineer for the No. 2, or northeast, district of British Columbia, in the place of **John D. Galloway,** who some months ago was promoted to the position of Provincial Mineralogist. For many years Mr. Lay was the general manager of the Josie mine, for the Le Roi No. 2 Mining Co., of London, and he held the position until the mine was sold to the Consolidated Mining & Smelting Company. Mr. Lay has done some important research work in connection with the treatment of the Rossland ores, and he has contributed articles on this and other subjects to the leading technical journals.

Obituary

William Mudge, general foreman at the Chino mines of the Ray Consolidated Copper Co. in Santa Rita, N. M., failed to rally after an operation for kidney trouble, and died in the Santa Rita hospital the night of June 25. He is survived by his wife and three small children. Mr. Mudge went to Santa Rita following the closing of the Mesabi Iron Co. at Babbitt, Minn., about a year ago. He had gained the respect of his fellow workers, and he and his family leave many friends in Santa Rita who are sadly grieved over his untimely demise. His family accompanied the body of Mr. Mudge to St. Paul, Minn., where the Masonic fraternity, of which he was a member, conducted funeral services.

Recent Technical Publications

Reviews, Abstracts, and References

Mineral Resources—Recent separates of the "Mineral Resources" series, obtainable on request from the U. S. Geological Survey, Washington, D. C., include: "Gold, Silver, and Copper in South Dakota and Wyoming in 1923," 5 pp., by C. W. Henderson; "Sulphur and Pyrites in 1924," 5 pp., by Helena M. Meyer; and "Gold, Silver, Copper, Lead, and Zinc in the Eastern States in 1924," 6 pp., by J. P. Dunlop. The last two papers are the first of the 1924 reports and the authors and the Survey are to be congratulated on their comparative timeliness.

Zinc Oxide Reduction—"Reduction of Zinc Oxide by Carbon" is discussed by G. A. Zeller and B. M. O'Harra in a technical bulletin recently issued by the School of Mines and Metallurgy, Rolla, Mo., 32 pp., obtainable on request. This is an investigation concerning the temperature at which reduction begins and the effect of various factors upon the rate at which it progresses.

Canadian Mining—The Dominion Bureau of Statistics, Ottawa, has recently issued the Annual Report of the Mineral Production of Canada for 1923. The report is well done and contains considerable information about the various mineral industries in addition to statistics of production. The names and addresses of all operators are given. Price 50c.; 231 pp.

Economic Geology—*Economic Geology* for June-July contains the following articles: "Manganese Precipitated by Micro-organisms," 10 pp., by George A. Thiel; "The Caridad Mine, Sonora, Mexico," 8 pp., by Alfred Wandke; "Experiments on the Origin of Phosphate Deposits," 16 pp., by W. A. P. Graham; "Genesis of the Adirondack Magnetites," 29 pp., by H. L. Alling; "Antipathy of Bornite and Pyrrhotite," 7 pp., by Geoffrey Gilbert; and "Asbestos Deposits of Cyprus," 5 pp., by C. L. Sagui. Copies are obtainable from the Economic Geology Publishing Co., Lancaster, Pa., for 65c. each.

Rock Asphalt — "Rock Asphalts of Alabama and Their Use in Paving" are discussed by George Huntington Clark in Special Report No. 13 of the Geological Survey of Alabama, University, Ala., 96 pp., obtainable on request.

Mineral Statistics — The following separates, containing statistics for 1920-1922, have been issued by the Imperial Mineral Resources Bureau: "Strontium Minerals," 7 pp., 4½d.; "Mica," 14 pp., 9½d.; and "Felspar," 11 pp., 6½d. The data cover production, imports, and exports of the principal producing countries. Obtainable from the British Library of Information, 44 Whitehall St., New York City.

Gold Dredging—In *Engineering* for June 5 is a 2-pp. article on the "Bucket Dredge for Alluvial Gold." Detailed drawings and a description are given of the dredge recently made by F. W. Payne & Son for the Nus River Gold Mines in Colombia. This is a ladder dredge with close-connected buckets, furnished with concentrating appliances, but dependent for its small amount of locomotion on being hauled by head and side lines. The magazine is obtainable for 1s. 3½d. from *Engineering*, 35 and 36 Bedford St., Strand, London, W. C. 2.

Patents

Vanadium Extraction—No. 1,540,154. June 2, 1925. Albert Wittig, Berlin, Germany. Vanadium ores are treated with a mixture of sulphuric and sulphurous acid, made by adding to the sulphuric acid at least five parts by weight of sulphur dioxide to a hundred parts of the ore to be treated, by which the vanadium is put into solution.

Classifier—No. 1,541,237. June 9, 1925. R. S. Trott, Denver. A combined classifier and thickener.

Slime Table—No. 1,541,246. June 9, 1925. S. H. Boylan, Joplin, Mo. A pivotally mounted table with several fabric-surfaced decks arranged parallel to one another. Means are provided for tipping the table at intervals to discharge its load.

Leaching Silicates — No. 1,544,493. June 30, 1925. H. P. Soulie-Cottineau, Villefranche, France, assignor to Le Cuivre Natif, Paris. Metal silicates in tailings are leached out with acid, after adding a small proportion of fluorspar to break up the silicates.

Electric Furnace—No. 1,542,562. June 16, 1925. Toussaint Levoz, Heer, Belgium. An electric furnace for melting and treating ores and metals, the principal feature of which is a refractory cone in the central portion of the hearth. Both arcs and electric resistances are used for heating.

Copper and Lead Ore Treatment—No. 1,542,935. June 23, 1925. W. E. Greenawalt, Denver. A process of treating copper and lead ores containing precious metals comprising smelting the copper ore to matte, crushing and roasting the matte, leaching it with a dilute acid solution to extract a portion of the copper, electrolyzing the resulting copper solution to deposit the copper and regenerate acid, returning the regenerated acid solution to the roasted matte and repeating the cycle until the copper in the roasted matte is sufficiently extracted, then mixing the roasted matte leach residue containing the precious metals and a small amount of copper with the lead ore, smelting the mixture, whereby most of the precious metals are concentrated into a lead bullion and the minor portion into a lead-copper matte, and adding the lead-copper matte so obtained to a new copper ore charge for copper matte smelting and repeating the cycle.

Magnetic Separation—No. 1,543,534. June 23, 1925. Georg Ullrich, Magdeburg, Germany, assignor to the Firm Fried. Krupp Grusonwerk Aktiengesellschaft, Magdeburg-Buckau, Germany. A process of wet magnetic separation on roller separators.

Purifying Metal—No. 1,541,778. June 16, 1925. R. F. Agricola, Saginaw, Mich., assignor of one-third to W. L. Agricola and one-third to K. A. Agricola, Detroit. Apparatus for introducing finely divided material into a gaseous current and thence into a bath of molten metal which is thereby purified.

Electrolytic Sheet Copper—No. 1,543,861. June 30, 1925. W. W. McCord, Wyandotte, Mich., assignor to McCord Radiator & Mfg. Co., Detroit. A method and apparatus for producing copper sheets electrolytically.

Powdered-Coal Feeder—No. 1,543,936. June 30, 1925. A. S. McMillan, St. Louis, Mo., and G. W. Whipple, Cherryvale, Kan. Means for feeding pulverized coal from a hopper into a furnace, by means of suction assisted by a stream of air at slightly above atmospheric pressure.

Jig—No. 1,543,987. June 30, 1925. E. M. Daugherty, Webb City, Mo. A jig with a central sieve compartment, and a sieve compartment at each side, connection being made by an inclined apron.

Copper Slag Treatment—No. 1,544,048. June 30, 1925. H. H. Stout, Douglas, Ariz. Copper is precipitated from molten slag at a definite temperature by the addition of metallic iron, the theory being that the iron combines with the copper-compound constituents of the slag, as such, to replace and precipitate the copper.

Tin Reduction—No. 1,544,198. June 30, 1925. E. B. Thornhill, Hurley, N. Mex., assignor to Thornhill-Anderson Co., Muskogee, Okla. Tin oxide ore is heated in a reducing atmosphere together with carbonaceous material and without fluxing agent, to such a temperature as to effect reduction and melting of the tin without fluxing the gangue, and without production of slag.

Electrodeposition of Gold—No. 1,544,227. June 30, 1925. W. R. Dodge, Timmins, Ont. An apparatus for the electrodeposition of precious metals, comprising a vessel containing anodes made up of concentric cylinders affixed to the vessel bottom, and gradually decreasing in height toward their common center, and concentric cathodes suspended from a spider, which may be rotated to agitate the solution.

Roasting Furnace — No. 1,542,150. June 16, 1925. A. V. Leggo, Melbourne, Victoria. Design of a shaft for multiple-hearth roasting furnaces, and means for attaching the rabble arms to such shaft.

Rock Drills

No. 1,543,816. June 30, 1925. L. C. Bayles, Easton, Pa., assignor to Ingersoll-Rand Co., Jersey City, N. J. A valve for rock drills.

No. 1,543,871. June 30, 1925. William Prellwitz, Easton, Pa., assignor to Ingersoll-Rand Co., Jersey City, N. J. A water-tube back-head connection for rock drills.

No. 1,543,883. June 30, 1925. F. M. Slater, Easton, Pa., assignor to Ingersoll-Rand Co., Jersey City, N. J. An automatic air-feed regulator for rock drills.

New Machinery and Inventions

The Genter Continuous Vacuum Thickener

A Description of the New Machines Installed in the Plants of the Consolidated Mining & Smelting Co. of Canada

By C. E. Chaffin
Eastern Manager, General Engineering Co.

FOR SOME YEARS the Genter pressure and vacuum thickener has been used in the beet-sugar factories of the West to thicken first carbonation juices. During the same period R. W. Diamond, superintendent of concentration for the Consolidated Mining & Smelting Co. of Canada, and his associates have modified and adapted the Genter vacuum machine to suit the exigencies of thickening various pulps in the company's metallurgical plants.

Thickening by means of ordinary settling tanks has been fairly satisfactory and has been the most common method of reducing the liquid content of ore pulps in metallurgical plants for a number of years past. Some of the advantages gained by the use of the new thickener in place of settling tanks are:

Much less floor space or installation area required for the entire equipment.

Lower first cost, particularly in cold climates, where the thickeners should be installed in the mill building or a heated place.

Much smaller volume of material in the thickeners and consequently in process.

Much shorter period of time required for material to pass through the thickener.

Greater conservation of heat.

Greater elimination of water or liquid from the material to be thickened and consequently a denser mud and resulting in a smaller vacuum filter installation.

Complete assurance of perfectly clear effluent from the thickener, even in cases where there is no decided difference between the gravity of the liquid and suspended solids.

The Genter thickener, in its simplest form, consists of tapered canvas socks placed on suitable wooden or perforated metal tubes and the tubes held in pipe frames, the whole being submerged in the pulp to be thickened. The inside of the supporting tubes and frames is connected to an automatic valve governing the cycle of filtration under vacuum and liquid counter-current for cake removal. At regular intervals the valve cuts off the vacuum-producing filtration and admits filtrate under pressure to the inside of the canvas tubes, which is sufficient to discharge the layer of solids collected on the canvas. After being dislodged from the canvas, the solids drop to the bottom of the tank and are withdrawn in the usual manner. Thus it is seen that the thickener operates in successive cycles, made up of comparatively long filtration periods and short, quick, counter-current cleansing periods. At the Consolidated Mining & Smelting Co.'s plants, this cycle has been standardized at four minutes for the filtration period and four seconds for the cleansing or blow-back period.

During the past six years, a good deal of experimental work has been done at Trail in the development of Genter vacuum thickener, and these machines have been installed in the new Sullivan concentrator at Kimberley, B C., to thicken the lead flotation concentrates and a portion of the zinc flotation tailings. Recently, it has been decided to install four Genter thickeners to thicken the pulp in the zinc-leaching plant at Trail. The filtrate in this case will be the zinc sulphate liquor and the solids will be the undissolved residue from the calcines.

Power Required Small

In the installations at the Sullivan concentrator, the filtrate is discharged through a barometric leg and the vacuum pump displacement required is therefore simply enough to keep the air out of the filtrate lines. The only other power necessary for this type of thickener is that required to turn the valve and the rakes in the bottom of the tank, which bring the thickened material to the central discharge opening. On the Genter thickeners, a 2-hp. motor is used to operate the main valve and a 5-hp. motor to operate the rakes. As these motors are carrying about half their rated loads, it is seen that 5 hp. per thickener is ample allowance for power. The valve used on these thickeners is simply a large, tapered, multiported plug valve, the plug of which turns at a uniform speed of one-quarter revolution per minute. The valve automatically connects the various groups of canvas tubes, first with the vacuum line and then with the blow-back or cleansing line.

About 22 in. of vacuum is maintained, and the blow-back or cleansing pressure is 15 lb. per square inch.

The thickened material is drawn off from the bottom of the tank through a small plug valve, which may be adjusted to regulate the consistency of the discharge. It is believed that a diaphragm pump would be a more satisfactory means of removing and regulating the thickened material, and this method is to be tried in the near future.

The new thickener is, in one sense, a filter, as the filtrate is drawn through canvas. For this reason, the liquid removed from the pulp is remarkably clear, and, if proper care is taken of the canvas tubes, a crystal clear filtrate may be obtained, which is of prime importance in the beet-sugar factories.

It is found that the filtration rate through the canvas tubes diminishes somewhat after the first few days of continuous operation, and at this mill it is the practice to scrub each tube (on its supporting frame) once every two weeks. This is accomplished and the filtration rate of the whole machine maintained at a uniform rate by scrubbing one-fourteenth of the total number of canvas tubes each day.

Labor Negligible

The labor required to operate and maintain the thickeners is so small that it is practically negligible. At the Sullivan concentrator, one man and a helper per shift operate and maintain the entire thickening and filtering departments, consisting of four Genter thickeners, five 6-ft., 6-disk American vacuum filters, conveyors, loading chutes, etc. This plant is treating 3,000 tons of ore per day and shipping approximately 450 tons of lead concentrates and 400 tons of zinc concentrates per day.

Below are given brief specifications of the commercial size Genter thick-

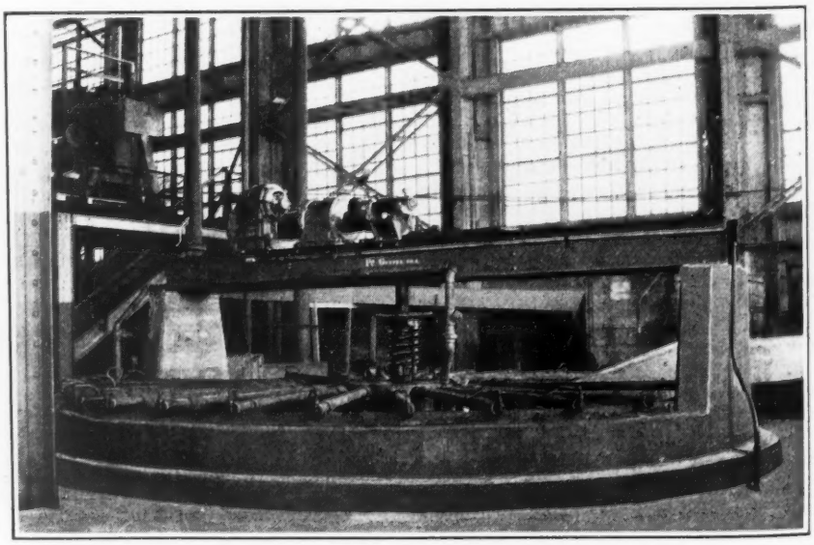


Fig. 1—Genter thickener handling tailings at Kimberley mill of Consolidated Mining & Smelting Co. of Canada

eners that have been in successful operation for almost two years in the Sullivan concentrator.

Thickener for Lead Flotation Concentrates

Two Genter thickeners were installed for thickening the lead flotation concentrates, but only one is normally used. Each thickener consists of 112 canvas tubes 4 in. in diameter and 6 ft. long, suspended in a concrete tank 12 ft. in diameter, with the necessary main valve filtrate receiver and discharge. Each canvas tube contains about 5.6 sq.ft. of filtering canvas and each thickener about 627 sq.ft. of effective canvas. Eight additional tubes could be installed in each thickener tank, which would increase the canvas area to about 672 sq.ft. per thickener.

The feed to this thickener is 450 tons of lead flotation concentrates per twenty-four hours. The feed to the thickener contains 43 per cent solids, and it is discharged at 56 per cent solids. The solids in the feed to this thickener are 95 per cent minus 200 mesh and assay 65.0 per cent lead, 6.0 per cent zinc, 6.5 per cent iron, and 1.0 per cent insoluble.

The filtrate is returned to the lead flotation circuit to conserve heat and flotation chemicals. The temperature of the lead flotation circuit is maintained at 20 deg. C. and the temperature loss in the Genter thickener is about ½ deg. C.

The quantity of filtrate discharged per twenty-four hours is 236 tons, or 56,640 U. S. gallons. This is equivalent to 39⅓ U. S. gallons per minute, or 0.0627 U. S. gallon per square foot of effective canvas per minute.

Flotation Tailings Thickener

One Genter thickener was installed to thicken a portion of the zinc flotation tailings (mill tailings). This thickener consists of 168 canvas tubes 4 in. in diameter and 6 ft. long, suspended in a concrete tank 18 ft. in diameter, with the necessary main valve filtrate receiver and discharge. Each canvas tube contains 5.6 sq.ft. of canvas and the whole thickener 940 sq.ft. of canvas. Twelve additional tubes could be installed in this thickener tank, which would increase the canvas area to 1.008 sq.ft.

The feed to this thickener is 500 tons of zinc flotation tailings per twenty-four hours. The feed to the thickener contains 25 per cent solids and it is discharged at 45 per cent solids. Below is given the screen size of the solids in the feed to this Genter thickener:

Mesh	Per Cent	Cum. Per Cent
20	0.0	0.0
28	0.4	0.4
35	1.2	1.6
48	2.4	4.0
65	5.6	9.6
100	11.6	21.2
150	11.8	33.0
200	11.8	44.8
—200	55.2	100.0

The solids in the feed to this Genter thickener assay 49.0 per cent iron, 8.5 per cent insoluble, and 36.0 per cent sulphur.

This filtrate is returned to the zinc flotation circuit to conserve heat and flotation chemicals. The temperature of the zinc flotation circuit is maintained at 30 deg. C. and the temperature loss in the Genter thickener is less than 1 deg. C.

The quantity of filtrate discharge from this thickener per twenty-four hours is 890 tons, or 213,600 U. S. gallons. This is equivalent to 148¾ U. S. gallons per minute, or about 0.16 U. S. gallon per square foot of canvas per minute.

Recently a Genter thickener of the same size as the tailings thickener has been installed to thicken the zinc flotation cleaner tailings, but it has not been operating long enough to obtain authentic operating data.

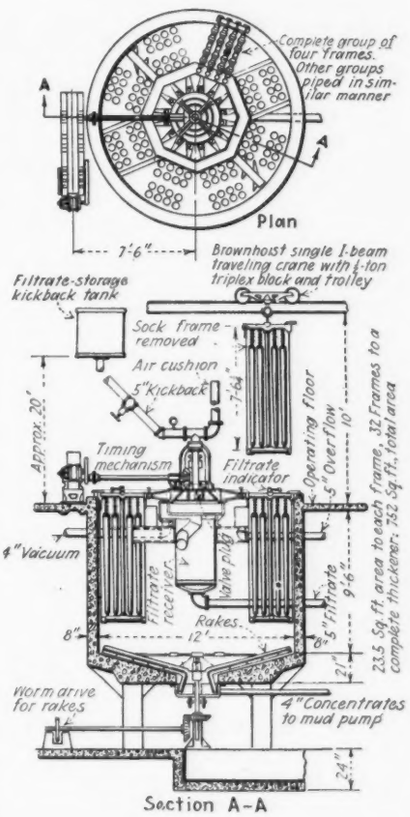


Fig. 2—Sketch showing construction of Genter thickener, metallurgical type, in elevation and plan

Leaching Plant Thickeners

From results obtained in an experimental thickener in the leaching plant at Trail, it was decided to install four Genter thickeners in this plant, and these thickeners are now being built. Each of these thickeners will consist of 224 canvas tubes 4 in. in diameter and 6 ft. long, suspended in a tank 18 ft. in diameter, with the necessary main valve and discharge. Each canvas tube will contain 5.6 sq.ft. of canvas and each thickener 1,254 sq.ft. of canvas, or 5,016 sq.ft. of effective canvas for the four thickeners.

The maximum feed per twenty-four hours to these four thickeners will be 480 tons of solids, plus 5.088 tons of liquor (zinc sulphate). The thickener feed will contain 7.31 per cent solids and it is expected to discharge it at from 40 to 60 per cent solids.

Below is given the screen size of the solids in the feed to this Genter thickener:

Mesh	Per Cent	Cum. Per Cent
100	0.8	0.8
150	6.5	7.3
200	9.1	16.4
—200	83.6	100.0

The solids in the feed to this Genter thickener will assay 8.0 per cent lead, 20.0 per cent zinc, 37.0 per cent iron, and 0.8 per cent sulphur (sulphide).

The filtrate from this thickener will be sent to the purification pachucas, Kelly filters and finally to the tank house, while the thickened discharge will be returned to the leaching circuit via the acid pachucas, settling tanks, neutral pachucas, classifiers, etc.

Diaphragm Pumps to Be Used for Discharging Solids

In this case both the filtrate (zinc sulphate liquor) and the thickened discharge are subject to further treatment in the plant. It is readily seen that the filtrate must be clear in order to reduce the subsequent purification and filtration operations to a minimum. It is also readily seen that the thicker the discharge the less liquor there will be returned to the circuit and the washing operations will be reduced to a minimum. It is proposed to discharge the solids from these thickeners by means of diaphragm pumps and to place screw conveyors inside the discharge lines to keep them open.

The maximum quantity of filtrate to be discharged from these four Genter thickeners per twenty-four hours will be 4,800 tons (sp.gr. 1.37) or 840,000 U. S. gallons. This is equivalent to 583⅓ U. S. gallons per minute, or about 0.12 U. S. gallon per sq.ft. of canvas per minute.

The General Engineering Co. and A. L. Genter, of Salt Lake City, owners of the various basic patents covering this type of thickener, have developed several mechanical and structural improvements in this device, while using the main features of the thickener tube frames and machine arrangement developed by Mr. Diamond and his associates at the plant of the Consolidated company.

Details of Thickener Construction

Briefly, the Genter thickener consists of grouping frames containing vertical tubular filter-elements around a central automatic valve and filtrate receiver, which, in turn, are located in the center of a circular tank containing the mixture to be thickened. Each tubular element is made either of perforated metal or corrugated wood, is approximately 4 in. in diameter and 6 ft. long, and when covered with a stocking fabric, it contains about 5.8 sq.ft. effective area. The top of the tubular element is closed and the drainage outlet is at the bottom. Four or more tubes are grouped in one frame having a common outlet. Compression springs keep each tubular element in

position against a leak-proof joint in the frame. Each frame, with its outlet for four or more elements, is connected, by a simple compression means, to the stationary central valve housing, which forms the top of the central filtrate receiver. This housing has an octagonal periphery so that every four frames that connect radially with the housing are parallel. This makes eight groups of four parallel frames, each radiating from the central housing.

The annular space between the central receiver and the outside tank forms the thickening chamber. Material being filtered and thickened is fed into this tank by any convenient means. (See Fig. 2.) A scraper operating near the bottom of this tank removes the thickened mud to a central outlet, whence it can be conveyed to the continuous filters either by a diaphragm pump or proper mud pump. These constitute the essentials of the metallurgical type thickener.

Thickening Chamber Can Be Subdivided to Advantage

The annular space between the central receiver and outside tank can also be subdivided into eight smaller tanks or compartments, which then likewise become grouped about the central valve and receiver. Each compartment tank comes around four parallel frames containing sixteen or more tubular elements. Each compartment has its own feed line and mud outlet. The mud is removed by gravity through a special spigot valve attached to the conical bottom of each compartment. This construction is used advantageously on materials that do not pack tightly on the bottom of the conical outlets and where a minimum of material must be kept in process. This constitutes the essential features of the thickener used in beet-sugar extraction plants.

The air in the central filtrate receiver is exhausted by constantly removing filtrate and vapors from it. This produces a suction action on the interior of all elements and causes filtration. The filtrate is drawn through the frame and valve housing conduits to the receiver and is removed constantly from the latter by means of a barometric seal or convenient pump. A portion is returned to the central timing valve under pressure for cake removal purposes. Filtration in various element groups is successively interrupted and alternated with short sudden counter-current shocks of filtrate, which remove the mud collected on the outer surfaces of the elements during filtration. This cycle action is caused by rotating a plug valve in sudden step-by-step movements within the housing. This plug valve has a port that matches at each pause in its rotation with any one port in the housing leading to a group of elements and cuts off the vacuum impulse and permits returned filtrate suddenly to hammer back into the respective elements and discharge the cake, which then falls to the bottom of the thickening tank. This step-by-step valve movement and cake discharge interruption on successive elements divide the action in each group into a relatively long suction-filtration impulse and a short sudden cut-off and cake discharge shock. As this cut-off and counter-current shock suddenly shifts around from one group to the next, it leaves preceding groups filtering, so that the greater number of elements are kept constantly filtering, while sediment is being constantly removed in rotation from the balance. This reversing shock is of about two seconds duration only. The filtration impulse can be anything from thirty seconds to several minutes, as the nature of the material being treated requires. The motor-operated mechanism actuating the sudden shifting of the valve plug is located at the side of the thickener and out of the way. It is simple, foolproof, and permits any desired cycle variation.

Leaks Can Be Promptly Detected

A special automatic filtrate indicator shows the condition of filtrate within each frame at each cake discharge period. This permits instantaneous detection of any leaky socks.

Frames containing leaky socks can be cut out of the system immediately by means of closing a 2-in. frame-control-valve connecting with the central automatic master valve. As there are no screwed joints between the frame and central housing and the elements and frame, any frame is lifted immediately from the tank and the faulty element can then be immediately replaced by releasing the spring holding it in position in the frame and inserting a spare tubular element in its place. This is all accomplished without interfering with the operation of the thickener in the least. If spare tubular elements are kept on hand, the entire thickener elements can be easily redressed without stopping operations at all.

In view of the fact that little or no air enters the filtrate system, due to using a liquid column under pressure for cake removal purposes, there is no necessity for a special vacuum pump for the thickener. The filtrate pump or barometic leg will produce enough vacuum for ordinary filtration purposes on cold liquids, and this action is aided on hot liquids by the use of a condenser between the thickener and the vacuum pump in thickening hot mixtures. The vacuum pump installed for the continuous vacuum filters will take care of the very minor extra vacuum displacement required in removing non-condensible gases or entrained air from thickening in the Genter vacuum thickener.

Operation Simple, Capacity High

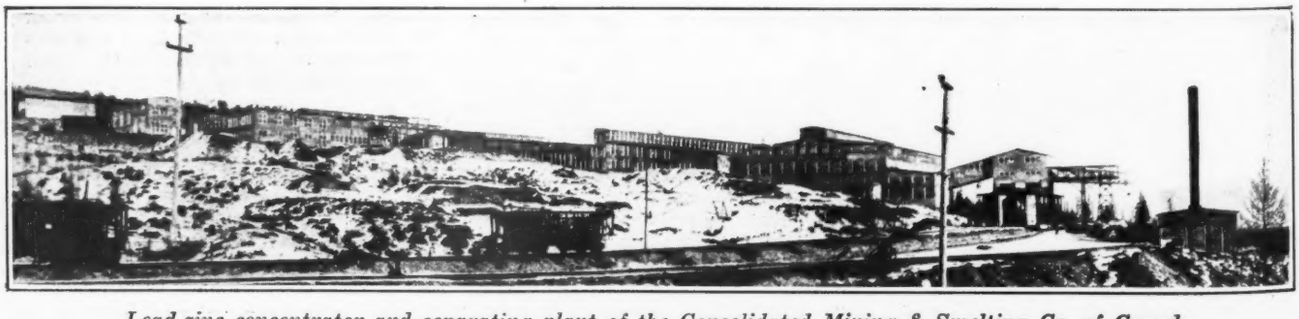
The novel construction and filtrate principles involved in the improved vacuum thickener make it very simple in operation and result in very high capacities per unit area installed.

The thickener is made in various sizes. The size most commonly used is located in a tank 12 ft. in diameter and contains thirty-two tube frames of four tubes each. The resulting thickening area is approximately 750 sq.ft. This unit will handle anywhere from 200 to 1,500 gal. of liquid per minute, depending on the nature of the material being thickened. On some metallurgical products one 12-ft. diameter Genter thickener is now handling the equivalent tonnage going through one decantation tank 60 ft. in diameter and doing the work much more efficiently.

The cloths last from two to eight months, according to the nature of the material being handled. On materials where frequent scrubbing of cloths or replacements may be necessary, its construction offers every advantage possible.

The new thickener has enlarged the field of application of continuous vacuum filters very materially, because it operates successfully on some products that cannot be economically thickened by other methods. The mud from the thickener is thick, creamy, free from lumps, and in perfect condition for further dewatering in filter of the type mentioned.

There is undoubtedly a wide application for this thickener in removing excess liquids from pulps in the various metallurgical, chemical and industrial plants. Although its use in metallurgical plants is comparatively recent, its adoption in the beet-sugar extraction plants in Western United States has been rapid. The first commercial installation was made by the Holly Sugar Corporation in 1920.



Lead-zinc concentrator and separating plant of the Consolidated Mining & Smelting Co. of Canada at its Sullivan mine, Kimberley, B. C.

The Market Report

Daily Prices of Metals

July	Copper N. Y. net refinery*	Tin		Lead		Zinc
	Electrolytic	99 Per Cent	Straits	N. Y.	St. L.	St. L.
2	13.50	55.50	57.125	8.00	7.70@7.80	7.025
3	13.625	55.625	57.25	8.025	7.80@7.85	7.025@7.05
4	.....	.....	.....	.....	.....	.....
6	13.65	55.625	57.25	8.10	7.90	7.075
7	13.625@13.75	55.625	57.375	8.00@8.15	7.95	7.10@7.125
8	13.75	56.125	57.625	8.00@8.15	7.95	7.15
Av.	13.643	55.700	57.325	8.055	7.875	7.080

*The prices correspond to the following quotations for copper delivered: July 2d, 13.75c.; July 3d, 13.875c.; July 6th, 13.90c.; July 7th, 13.875@14c.; July 8th, 14c.

The above quotations are our appraisal of the average of the major markets based generally on sales as made and reported by producers and agencies, and represent to the best of our judgment the prevailing values of the metals for deliveries constituting the major markets, reduced to the basis of New York cash, except where St. Louis is the normal basing point, or as otherwise noted. All prices are in cents per pound. Copper is commonly sold "delivered," which means that the seller pays the freight from the refinery to the buyer's destination.

Quotations for copper are for ordinary forms of wire bars, ingot bars and cakes. For ingots an extra of 0.05c. per lb. is charged and there are other extras for other shapes. Cathodes are sold at a discount of 0.125c. per lb.

Quotations for zinc are for ordinary Prime Western brands. Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

The quotations are arrived at by a committee consisting of the market editors of *Mining Journal-Press* and a special representative of the Bureau of Mines and the Bureau of Foreign and Domestic Commerce.

London

July	Copper			Tin		Lead		Zinc	
	Standard		Electrolytic						
	Spot	3M		Spot	3M	Spot	3M	Spot	3M
2	60 3/8	61 3/8	64	252 3/4	255	33 5/16	32 11/16	34 5/16	33 11/16
3	60 1/2	61 1/2	64 1/2	253 5/8	255 7/8	33 1/2	33 1/16	34 1/4	33 3/4
6	60 5/8	61 5/8	64 1/2	253 3/4	255 7/8	34 1/8	33 3/8	34 3/8	33 15/16
7	60 3/4	61 3/4	64 3/4	254 5/8	257	34 1/8	33 3/8	34 3/8	34
8	61 1/8	62	65	256	258 1/4	33 15/16	33 3/16	34 9/16	34 3/16

The above table gives the closing quotations on the London Metal Exchange. All prices in pounds sterling per ton of 2,240 lb.

Silver, Gold, and Sterling Exchange

July	Sterling Exchange "Checks"	Silver		Gold London	July	Sterling Exchange "Checks"	Silver		Gold London
		New York	London				New York	London	
2	4.85 1/2	69 3/8	32	84s11d	6	4.85 5/8	68 7/8	31 3/4	84s11d
3	4.85 5/8	69 3/8	32	84s11d	7	4.85 5/8	69 1/4	31 7/8	84s10 1/2d
4	.....	...	31 15/16	.....	8	4.85 5/8	69 5/8	32 1/8	84s10 1/2d

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London silver quotations are in pence per troy ounce of sterling silver, 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command one-half cent premium.

Copper and Lead Sales Larger at Advancing Prices

New York, July 8, 1925—A holiday week in midsummer has been no deterrent to good business in the non-ferrous metal market. Demand has been excellent for copper, lead, and tin, and prices for all of these metals have advanced. Zinc, also, seems to be on the upward trend and to have definitely broken away from the 7c. level, though domestic sales have been small. Silver is practically unchanged.

Copper Now Firm at 14c.

The copper market has been active for several days. The metal offered at 13¾c., delivered, last Thursday was quickly absorbed and on Friday 13⅞c. was the ruling price in Connecticut, with 14c. done in the Middle West. This level was generally maintained on Monday also, but on Tuesday copper became rather scarce at 13⅞c. for most any delivery and 14c. was generally quoted at the close of the day. Business was booked in the Middle West as high as 14⅛c. Today all producers are firm at 14c., Connecticut delivery, and several sales have been made at that level. The total volume of sales for the week has not been quite so great as that of two weeks ago, but has been of substantial proportions. Most consumers are buying for July or August shipment.

The advance has been caused by the continued good consumption and to a realization of the fact that with the present reduced rates of production, refinery stocks are decreasing to a point below which it would be dangerous to go. Official figures on stocks on July 1 are not yet out, but elaborate guesses have been made which make an extremely bullish argument for the market. Export demand has been good also this week, mostly around 14c., c.i.f. Since the principal American agencies have advanced their prices in the last two days to 14.10@14.20c., most of the buying has stopped. Threatened labor trouble in England has made buyers there more cautious, for all metals.

Lead Sells Above 8c.

The American Smelting & Refining Company's contract price for New York lead continues at 8c.

Thursday was rather a quiet day, but inquiries began to be numerous on Friday, after the advance in London, and most producers have found the market decidedly active ever since, though things are a little quieter today. Both consumers and speculators have been anxious buyers, and it is probable that much of the consuming demand is semi-speculative, as several interests have bought that asserted they were well covered for the next month or two when the market was weak a few days back. Two producers have done a particularly large business, mostly for July and August shipment. Most consumers seem well provided for their July requirements. On shipment from the Middle West, as high as 8.25c. has been paid at the principal Eastern points of consumption, owing to the fact that the Smelting company has not been a particularly free seller at its official price of 8c. Demand at premium prices has fallen off a little in the last two days, however, and there seems no cause for alarm by consumers about a runaway market. The buying during the last week has been very general among the different classes of consumers, with the possible exception of storage battery makers.

Corroding grades are somewhat scarcer than usual; they have sold at premiums of $2@$3 per ton above common lead.

Zinc at 7.15c., Thanks to Foreign Demand

Galvanizers have bought zinc on a decidedly moderate scale, and the same can be said for brass manufacturers. At the present prices for galvanized sheets, there has been great objection to paying more than 7c. for zinc. Also, with ore at $49 to $50, smelters have not been at all anxious to sell zinc at 7c., so it has been largely a stand-off so far as domestic business is con-

cerned. The London market has advanced, however, and bids for export have brought the market up to 7.15c., which has been done today on several orders, both for domestic and export. High-grade continues to sell in satisfactory volume at 8¼@8¾c., delivered, and Brass Special commands 10 points premium over Prime Western. Most of the sales have been for July or early August shipment.

Correction—Spot zinc in London, July 1, was 34¼ instead of 34⅞ as published in the July 4 issue.

Tin Active the Last Few Days

Since the holiday, tin buying has been on a good scale, both by consumers and dealers. July and August deliveries are generally desired. Spot metal is decidedly scarce, as it has been in recent weeks, and has commanded premiums of about ¼c. over metal at dock, which latter is represented in our quotations. September tin is about ½c. less. The 99 per cent grade of tin continues to be in considerably freer supply than Straits.

Silver Market Quiet

The New York silver market was very quiet just prior to the Fourth of July holiday, although prices stiffened somewhat on the scarcity of supplies. On July 6 a further decline followed in sympathy with London and the local quotation dipped below 69c. for the first time since June 20. Good buying by the Indian bazaars caused an upward reaction and prices rallied considerably. The market closed steady, with sellers inclined to hold back.

Mexican Dollars; July 2nd and 3rd, 53⅜c.; July 4th, holiday; July 6th, 53c.; July 7th, 53¼c.; July 8th, 53½c.

Francs and Lire Weak

The weakness in French and Italian exchange continues. Closing cable quotations on Tuesday, July 7, were as follows: francs, 4.665c.; lire, 3.69c.; and marks, 23.805c. Canadian dollars, 3/32 per cent premium.

Other Metals

Quotations cover large wholesale lots unless otherwise specified.

Aluminum—99 per cent grade, 28c. per lb.; 98 per cent, 27c. London, £118 per long ton for 98 per cent.

Antimony—

Chinese brands, spot, 19c. per lb.; July, 17@18c.; August, 16.25@16.50c.

Cookson's "C" grade, spot, 21c.

Needle and oxide nominally unchanged from quotations in July 4 issue.

Bismuth—$2.65@$2.70 per lb., in ton lots. London, 10s.

Cadmium—60c. per lb.

Iridium — $400 per oz. Nominal. London, £80.

Nickel—Ingot, 34c.; shot, 35c.; electrolytic, 38c.; London, £170@£175 per long ton.

Palladium—$75@$83 per oz. Crude, $65. London, £16.

Platinum—$120 per oz. refined officially quoted. Sales also at $117@$118. Crude, $115. London, £25 per oz. for refined.

Quicksilver—$84 per 75-lb. flask. San Francisco wires $82.75. Break in Italian exchange has probably prevented a further advance in price. London, £14¼.

The prices of Cobalt, Germanium Oxide, Lithium, Magnesium, Molybdenum, Monel Metal, Osmiridium, Osmium, Radium, Rhodium, Ruthenium. Selenium, Tantalum, Tellurium, Thallium, Tungsten and **Zirconium** are unchanged from the July 4 issue.

Metallic Ores

Tungsten Ore—Per unit, N. Y.:

High-grade wolframite, $12 per unit. Ordinary quality, $11.50@$11.75. Scarce.

High-grade Western scheelite, $11.75 @$12.

Chrome, Galena and **Pyrite Radio Crystals, Iron Ore, Manganese, Molybdenum, Tantalum,** and **Vanadium Ores** are unchanged from quotations in the July 4 issue.

Zinc Ore Unchanged— Lead Lower

Joplin, Mo., July 3, 1925

Zinc Blende	Per Ton
High	$54.60
Premium, basis 60 per cent zinc	$52.00@$53.00
Prime Western, 60 per cent zinc	$50.00
Fines and slimes, 60 per cent zinc	$48.00@$46.00
Average settling price, all.	$48.70
Lead Ore	
High	$114.12
Basis 80 per cent lead	$100.00
Average settling price, all	$110.32

Shipments for the week: Blende, 15,142; lead, 2,062 tons. Value, all ores the week, $935,730.

Production was lowered to approximately 10,600 tons by mills closing, some Wednesday, others Thursday, and all the remainder closing Friday night over the Fourth of July. A few of the mills will remain idle all month, some will resume work after one week's vacation, and some will restart Monday, so there will be another week of short production.

Sellers disposed of about the tonnage output of the week, accepting last week's price level, after some deliberation of holding for $1 advance in prices.

Platteville, Wis., July 4, 1925

Zinc Blende	Per Ton
Blende, basis 60 per cent zinc	$51.50
Lead Ore	
Lead, basis 80 per cent lead	$110.00

Shipments for the week: Blende, 948 tons; lead, 66 tons. Shipments for the year: Blende, 23,603; lead, 1,008 tons. Shipments for the week to separating plants: 1,545 tons blende.

Non-Metallic Minerals

Amblygonite, Andalusite, Asbestos, Barytes, Bauxite, Beryl, Borax, Celestite, Chalk, China Clay, Corundum, Diatomaceous Earth, Emery, Feldspar, Fluorspar, Fuller's Earth, Garnet, Gilsonite, Graphite, Greensand, Gypsum, Ilmenite, Iron Oxide, Lepidolite, Limestone, Magnesite, Manjak, Mica, Monazite, Ocher, Ozocerite, Phosphate, Potash, Pumice, Pyrites, Quartz Rock Crystals, Rutile, Silica, Spodumene, Sulphur, Talc, Tripoli, and **Zircon** are unchanged from prices in the July 4 issue.

Mineral Products

Arsenious Oxide (White arsenic)—4¼@4¾c. per lb. Occasional sales.

Copper Sulphate, Sodium Nitrate, Sodium Sulphate, and **Zinc Oxide** are unchanged from prices in the July 4 issue.

Ferro-Alloys

Ferrocerium, Ferrochrome, Ferromanganese, Ferromolybdenum, Ferrosilicon, Ferrotitanium, Ferrotungsten, Ferro-uranium and **Ferrovanadium** are unchanged from the prices in the July 4 issue.

Metal Products

Rolled Copper—Sheets, 21¾c.; wire, 15½c. per lb.

Nickel Silver, Yellow Metal, Lead and **Zinc Sheets** are unchanged from the issue of July 4.

Refractories

Bauxite Brick, Chrome Brick, Firebrick, Manesite Brick, Silica Brick, and **Zirkite** are unchanged from prices in the July 4 issue.

Heavier Steel Buying Expected

Pittsburgh, July 7, 1925

There has been no closing of steel-producing mills, as sometimes occurs in this midyear period. Several sheet plants have closed for a week or two, but no other finishing mills. Steel mill operations will not be much lighter this month than last, when there was an average of about 70 per cent, making a vastly stronger finish for the half year than occurred in 1924.

The trend of steel buying is not distinctly downward at the present time. Some mills report slightly heavier bookings in June than in May. The familiar tradition that July is naturally a dull month in steel buying is not well supported by precedent, for as often as not there has been an increase in July. As stocks in buyers' hands are particularly low and prospects for consumption are really quite good, heavier buying is to be expected, not on account of confidence but on account of necessities. Confidence, however, has been returning.

Steel prices on the whole are showing more steadiness than for several months, during which time there were few actual declines but a sagging tendency in the majority of lines. Sheet mills have definitely firmed up in quoting galvanized sheets, having a 4.20c. figure, but this is not tested yet, as there are old quotations out. Hoops and bands are remarkably firm at 2.40c. base, and bars are steady at 2c.

Pig Iron—There are no menacing stocks in bessemer or basic and the outlook is that the next change will be an improvement. Meanwhile the market is quiet and steady at $19 for bessemer, $18 for basic and $18.50 for foundry, f.o.b. Valley furnaces.

Connellsville, Coke — Spot furnace, $2.75@$2.85; spot foundry, $3.75@$4.25.

Company Reports

Central Eureka Mining Co.

Gold; California

During the year ended with April, 1925, the Central Eureka Mining Co. of California produced 48,883 tons of ore, from which was recovered $531,821 in bullion and concentrates. Disbursements were as follows: Miscellaneous, $95,854; mining cost, $314,304; milling cost, $19,168; sundries, $83,735. The cash in treasury totaled $14,876 and bonds to the value of $105,190, a total of $120,067. Mine supplies on hand April 1, 1925, total $13,192, bringing the total of liquid assets to $133,259.

Superior & Boston Copper Co.

Copper; Arizona

During the quarter from Jan. 1 to March 31, the Superior and Boston Copper Co. did 1,309 ft. of underground development work, compared with 850 ft. during the preceding quarter, and shipped 2,553 dry tons of ore to the smelters. This ore averaged 3.76 per cent copper, 8.18 oz. silver and contained 192,135 lb. copper and 20,884 oz. silver. After deducting freight and treatment charges, the net smelter returns amounted to $20,850.41, or $8.17 per ton.

The major portion of the development work finished during the quarter was done on the Dewey vein with satisfactory results. A raise driven from the 800 to the 600 level has greatly improved ventilation and developed ore for a height of 130 ft.

The unwatering of the McGaw shaft below the 1,200 level, the retimbering of the 1,400 level and much other preparatory work having been completed, actual sinking was started in March and the shaft was sunk, by the end of the quarter, 47 ft., to a depth of 58 ft. below the 1,400 level. At a depth of 40 ft. below the 1,400 level the formation changed from diabase to schist. This block of schist is again underlain with diabase and it is planned to sink through this lower diabase and again enter schist before crosscutting for the faulted portion of North, or Old Dominion vein.

The exact position of the lower schist is not definitely known, but it will probably be below the 1,700 level. As the history of the district has proved that the best orebodies of the Old Dominion vein are found in siliceous sedimentary rocks and not between diabase walls, it seems important that the shaft be carried into the lower schist before exploratory crosscuts are driven.

Alaska Treadwell, Alaska Mexican, and Alaska United Gold Mining Cos.

A joint report covering the operations of these companies for the year 1924 says of the Treadwell Yukon Co.'s Mayo venture: The mining properties situated in the Mayo district, Y. T., are now being operated at a profit; and all the issued stock of this company is owned 30 per cent by the Alaska Treadwell, 10 per cent by the Alaska Mexican, 10 per cent by the Alaska United and 50 per cent by the Bunker Hill and Sullivan companies; $290,000 has so far been paid for the properties now being operated and $104,000 additional payments in 1925 and 1926 will completely pay for all the properties held under option.

As far as the development work has proceeded and at the present rate of milling, it is estimated the property has about five years' life; but it is fully expected that the drain tunnel level will yet encounter the same good shoots of ore that have been found on the upper levels, and that a general extension of the underground workings northerly and southerly will expose more ore and thus prolong the life of the property. If and when the mine justifies it, the milling capacity can easily be increased to 200 tons per day.

With silver at 60c. per oz. and lead at 6c. per lb. and after paying all freight, treatment, and marketing charges, it is estimated an operating profit of $8 per ton can be made from a mill-feed assaying 35 oz. silver and 4 per cent lead.

The policy of looking for new mining properties is being continued and several prospects are being investigated.

The following tabulation summarizes the operations of the Treadwell Yukon Co., Ltd., for the year 1924:

Receipts		
Returns from ore production	$425,424.36	
Commercial profits	548.76	
Income from lease, McGrath-Nixon Fork mill	8,229.00	
Interest and exchange	7,555.73	
Salvage—McGrath supplies and equipment	5,106.73	
		$446,864.58
Expenditure		
Ore production expense	$183,632.35	
General expenses	21,515.73	
Interest	1,768.44	
Taxes	1,095.77	
General prospecting	10,906.84	
McGrath-Nixon Fork venture	9,932.45	
Property—Mayo	299,376.53	
Plant and equipment—Mayo	177,995.27	
Roads and trails—Mayo	937.38	
Sundry adjustments	185.16	
		707,345.92
Excess of all expenditure over all receipts for the year of		$260,481.34
Balance Sheet Dec. 31, 1924		
Assets		
Property and plant—Mayo	$968,419.65	
Property and plant—McGrath	68,758.14	
Cash	10,817.25	
Supplies	283,543.80	
Account receivable	9,936.62	
Other assets	2,658.71	
		$1,344,134.17
Liabilities		
Accounts payable	$45,961.58	
Personal accounts—Mayo	14,070.05	
Bank of Montreal, Dawson (overdraft)	25,430.40	
		85,462.03
Leaving a surplus of assets over liabilities of		$1,258,672.14

The following tabulations summarize operations for the year 1924, and the activities on Douglas Island. Some income is realized from the salvaging and cleaning-up operations, as well as from the operation of the power plants and the other joint utilities:

Alaska Treadwell Gold Mining Co.

Receipts		
Interest	$91,538.93	
Income from hydro-electric power plants	14,529.91	
Salvage—equipment sold	14,264.85	
Sundry	19,000.71	
		$139,334.40
Expenditure		
Liquidating dividend No. 1	$200,000.00	
Salvage expense	7,701.02	
Sundry	18,831.57	
		226,532.59
Leaving an excess of all expenditure over all receipts for the year of		$87,198.19
Balance Sheet Dec. 31, 1924		
Assets (exclusive of property and plant)		
Cash	$164,653.35	
Bonds	1,090,535.27	
Treadwell Yukon Co., Ltd., stock	449,992.60	
Alaska United Gold Mining Co.	255,515.51	
Alaska Juneau Gold Mining Co.	135,547.33	
Sundry	108,752.54	
		$2,204,996.60
Liabilities		$29,894.72
Leaving an excess of assets over liabilities		$2,175,101.88

Alaska Mexican Gold Mining Co.

Receipts	$16,129.99
Expenditure	4,198.06
Leaving an excess of all receipts over all expenditure for the year of	$11,931.93

Assets (exclusive of property and plant)		
Cash	$43,470.88	
Bonds	26,730.00	
Treadwell Yukon Co., Ltd., stock	149,997.20	
Sundry	4,194.94	
		$224,393.02
Liabilities		
Liabilities		None
Leaving an excess of assets over liabilities		$224,393.02

Alaksa United Gold Mining Co.

Receipts	$30,264.48
Expenditure	23,530.38
Leaving an excess of all receipts over all expenditure for the year of	$6,734.10

Assets (exclusive of property and plant)		
Cash	$1,412.78	
Treadwell Yukon Co., Ltd., stock	149,997.20	
Supplies	4,361.03	
		$155,771.01
Liabilities		
Alaska Treadwell Gold Mining Co.		$255,515.51
Leaving an excess of liabilities over assets		$99,744.50

Mining Stocks—Week Ended July 4, 1925

Stock	Exch.	High	Low	Last	Last Div.
COPPER					
Anaconda	New York	39⅛	38¼	39¼	Jy.18, Au.24, Q 0.75
Arcadian Consol.	Boston	1⅛	1⅛	1⅛	
Ariz. Com'l	Boston	10⅞	10⅝	10⅞	Ja.19, Ja 31 SA 0.50
Calaveras	N. Y. Curb			2	
Calumet & Arizona	New York	49¼	47½	48½	Jn.15, Jn.22 Q 0.50
Calumet & Hecla	Boston	133½	13	13⅛	Ja.30, Mh.4 [0.50
Canario Copper	N. Y. Curb	5⅛	5¼	5⅛	
Cerro de Pasco	New York	52½	51	51¼	Ap.23 My.1, Q 1.00
Chile Copper	New York	34	33⅛	33⅛	Jn.3, Jn.29, Q 0.62½
Chino	New York	21⅛	21½	21½	Sept., 1920 0.37½
Con. Coppermines	N. Y. Curb			2½	
Copper Range	Boston	20⅛	19½	20⅛	Ap.9, My.4 1.00
Crystal Copper	Boston Curb	*58	*50	*56	
East Butte	Boston	4	3½	3½	Dec., 1919 0.50
First National	Boston Curb	*19	*18	*18	Feb., 1919 0.15
Franklin	Boston	*90	*60	*90	
Granby Consol	New York	14½	14¼	14⅜	May, 1919 1.25
Greene-Cananea	New York	13	12⅞	12⅞	Nov., 1920 0.50
Hancock	Boston			*75	
HoweSound,new,r. t.c.	N. Y. Curb			16½	April, 1924 0.05
Inspiration Consl.	New York	26	25⅛	25⅛	Jn.18, Jy.6, Q 0.50
Iron Cap	Boston Curb	1⅛	1 7/16	1⅛	May, 1923 0.15
Isle Royale	Boston	11⅜	11⅛	11⅛	Sept., 1923 0.50
Jerome Verde Dev	N. Y. Curb	1⅛	1	1	
Kennecott	New York	51⅞	50	51⅛	Jn.5, Jy.1, Q 0.75
Lake Copper	Boston	1⅛	1⅛	1⅛	Jn.1, Jn.15 Q 0.50
Magma Copper	NewYork	41	39⅜	39⅜	Jn. 15, Jy. 15, 0.75
Mason Valley	N. Y. Curb	1⅜	1⅜	1⅜	
Mass Consolidated	Boston	*50	*50	*50	Nov., 1917 1.00
Miami Copper	New York	8⅞	8⅜	8⅜	My.1 My.15 Q 0.25
Mohawk	Boston	30	27⅛	29⅛	My. 2, Jn. 2 1.00
Mother Lode Coa.	New York	7⅛	6⅞	7	Jn. 12, Jn. 30 0.37½
Nevada Consol.	New York	12⅝	12⅛	12⅛	Sept., 1920 0.25
New Cornelia	Boston	19⅝	19⅛	19⅛	My. 8, My. 25Q 0.25
North Butte	Boston	1	*95	1	Oct., 1918 0.25
Ohio Copper	N. Y. Curb	*83	*75	*78	No.14, De.2 0.05
Old Dominion	Boston	20	18	20	Dec., 1918 1.00
Phelps Dodge	Open Mar.	†105	1100		Jn.20, Jy.2 Q 1.00
Quincy	Boston	23	21½	23	Mar., 1920 1.00
Ray Consolidated	New York	13⅛	12¼	13	Dec., 1920 0.25
Ray Hercules	N. Y. Curb			14	
St. Mary's Min. Ld.	Boston	34⅜	34	34⅛	Ap. 20, My.20, 3.00
Shannon	Boston			*60	Nov., 1917 0.25
Shattuck Arizona	New York	65	62¼	63¼	Jan., 1920 0.25
Superior & Boston	Boston	1⅛	1	1⅛	
Tenn. C. & C.	New York	11⅛	10⅛	11⅛	De.31, Ja.15,Q 0.25
United Verde Ex.	N. Y. Curb	23½	23⅛	23⅛	Jy. 6, Aug. 1 0.50
Utah Copper	New York	90⅛	88⅛	90⅛	Mh.20,Mh.31,Q1.00
Utah Metal & T.	Boston	*45	*45	*45	Dec., 1917 0.30
Victoria	Boston			*40	
Walker Mining	Salt Lake	2.35	2.30	2.30	
NICKEL-COPPER					
Internat. Nickel	New York	30⅛	29⅜	30	March, 1919 0.50
Internat. Nickel pfd.	New York	99½	99½	99½	Ap.16, My.1, Q 1.50
LEAD					
Carnegie Lead & Zinc	Pittsburgh	7⅛	7¼	7¼	
Gladstone M. M. Co.	Spokane	*24⅛	*23½	*23⅛	Jy. 1, Jy. 10 0 0½
National Lead	New York	151	146	148	Jn.12, Jn.30, Q 2.00
National Lead pfd.	New York	117	117	117	My.22, Jn.15 Q 1.75
St. Joseph Lead	New York	37	35¾	36⅝	Jn. 9, Jn. 22 0.50
ZINC					
Am. Z. L. & S.	New York	7⅞	7	7⅛	May, 1920 1.00
Am. Z. L. & S. pfd.	New York	29⅛	28⅛	28⅛	Nov., 1920 1.50
Butte C. & Z.	New York	5⅜	5⅛	5⅛	De.10, De.24 0.50
Butte & Superior	New York	12⅛	10⅜	10⅜	Mh.19, Mh.31 0.50
Callahan Zn-Ld.	New York	2⅛	2⅛	2⅛	Dec., 1920 0.50
New Jersey Zn.	N. Y. Curb	185⅞	185	185	Jn.20,Jy. 10 Ex. 2.00
United Zinc	N. Y. Curb			*35	
Yellow Pine	Los Angeles	*67	*64	*64	De.10,De.15 Q 0.04
GOLD					
Alaska Juneau	New York	1⅞	1⅞	1⅞	
Argonaut	Toronto	*24⅜	*24⅜	*24⅜	
Barry-Hollinger	Toronto	*45⅛	*45	*45	
Carson Hill	Boston	*50	*50	*50	
Consol. W. Dome L.	Toronto	*13	*12½	*12½	
Cresson Consol. G.	N. Y. Curb	3⅛	3⅛	3⅛	Mh.31, Ap.10 Q 0.10
Crown Reserve	Toronto	*29	*28⅛	*28⅛	Jan 1917 0 05
Dome Mines	New York	15	14	14	Mh.31,Ap.20,Q 0.50
Golden Cycle	Colo. Springs			1.40	Dec.11, 1924 0.03
Hollinger Consol.	Toronto	14.75	14.65	14.70	Jn. 29, Jy. 15, 0.08
Homestake Mining	New York	44	44	44	Jn.20, Jn.25 M 0.50
Kirkland Lake	Toronto	*39½	*38⅛	*38⅛	
Lake Shore	Toronto	5.80	5.77	5.79	Mh.2, Mh.16, 0 05
McIntyre-Porcupine	New York	17⅛	17⅛	17⅛	My.1, Jn.1, 0.25
Newray	Toronto	*21	*21	*21	
Night Hawk Pen.	Toronto	*23	*23	*23	
Portland	Colo. Springs			*40	Oct., 1920 0.01
Rand Mines	New York	37	37	37	Fe.17, Fe.25 1.79
Teck-Hughes	Toronto	1.38	1.38	1.38	
Tom Reed	Los Angeles	*40	*25	*40	Dec., 1919 0.02
Tough-Oakes	Toronto	*31	*30	*30½	
United Eastern	N. Y. Curb			*48	July, 1924 0.05
Vipond Cons.	Toronto	1.05	1.03	1.03	
Wright-Hargreaves	Toronto	4.45	4.35	4.35	Jn.15, Jy.1 5.00
GOLD AND SILVER					
Black Oak	N. Y. Curb			*81	
Con. Cortez	N. Y. Curb	*7	*7	*7	
Con. Virginia	San Francisco	₹3½	3½	3½	
Continental Mines	N. Y. Curb	1⅝	1⅝	1⅝	
Dolores Esperanza	N. Y. Curb			*51	July, 1923 0.05
Premier Gold	N. Y. Curb	2 7/16	2⅛	₹2⅛	Jn.18, Jy.1, 0.08
Tonopah Belmont	N. Y. Curb	*60	*60	*60	Mh.15, Ap.1 0.05
Tonopah Divide	N. Y. Curb			*23	Oct., 1923 0.10
Tonopah Extension	N. Y. Curb	1⅞	1⅞	1⅞	Mh.11, Ap.1, Q 0.05
Tonopah Mining	N. Y. Curb	3⅜	3⅜	3⅜	Mh.31, Ap. 21, 0.07½
Unity Gold	N. Y. Curb	*85	*80	*85	
West End Consol.	N. Y. Curb	*55	*55	*55	Mar., 1923 0.05
Yukon Gold	N. Y. Curb	*35	*35	*35	June, 1918 0.02

Stock	Exch.	High	Low	Last	Last Div.
SILVER					
Alvarado	Boston Curb			*50	Oct., 1920 0.50
Beaver Consol.	Toronto	*29¼	*28½	*28¼	May, 1920 0.03
Castle-Trethewey	Toronto	*84½	*84	*84	
Coniagas	Toronto	1.55	1.50	1.50	May, 1924 0.12½
Keeley	Toronto	1.81	1.75	1.75	Mh.1, Mh.15SA 0.12
Kerr Lake	N. Y. Curb	1⅜	1⅜	1	Ap.1, Ap.15,Q 0.12½
La Rose	Toronto	*48⅛	*47½	*47⅜	Apr., 1922 0.10½
Lorrain Trout Lake	Toronto	1	*95	*95	Jy. 2, Jy.15 0 05
McKinley-Dar.-Sav.	Toronto	*29	*27	*27	Oct., 1920 0.03
Mining Corp. Can.	Toronto	2.71	2.68	2.68	Sept., 1919 0.12½
Nipissing	N. Y. Curb	4⅞	4½	4⅝	Jn.30, Jy.20, Q 0.15
Ontario Silver	New York	6½	6¼	6½	Jan., 1919 0.50
Temiskaming	Toronto	*18	*18	*18	Jan., 1920 0.40
SILVER-LEAD					
Ahumada	New York	11⅛	10⅜	11⅛	Jn.15, Jy.2, Q 0.07½
Bingham Mines	Boston	29¼	28¼	28¼	Jn.20, Jn.30 Q 0.50
Cardiff M. & M.	Salt Lake	1.32½	1.30	1.32½	De.16, No.18 0.10
Chief Consol.	Salt Lake	3.85	3.50	3.50	Ap.10, My. 1 0.10
Columbus Rexall	Salt Lake	*9	*9	*9	Aug., 1923 0.05
Erupcion	Boston Curb	3⅛	3	3 1/16	Jn.15, Jy.2, Q 0.07½
Federal M. & S.	New York			16⅛	Fe.26, Mh.15 Q 1.75
Federal M. & S. pfd.	New York	56	54	54	My.25, Jn.15,Q 1.75
Hecla Mining	N. Y. Curb	13⅜	13⅛	13½	Jn.15, Jy.1 Q 0.75
Iron Blossom Con.	Salt Lake			*39	Oc.25, 1924 0.01½
Iron King Mining	Salt Lake	*58	*53	*58	
Keystone Mining	Salt Lake	*86	*84	*84	Au.12, Au.26 0 07½
Mammoth Mining	Salt Lake	2.40	2.30	2.40	My.15, My.25 0.10
Marsh Mines	N. Y. Curb			*4	June, 1921 0.02½
Park City	Salt Lake	5.75	5.65	5.65	Jn.15, Jy.1 Q 0.15
Park Utah	Salt Lake	5.80	5.55	5.55	April, 1924 0.15
Prince Consol.	Salt Lake	*52	*44	*44	
Silver King Coal	Salt Lake	7.95	7.75	7.75	Jn.20, Jy.1, Q 0.25
Silversmith	Spokane	*18	*16½	*17	Jy.1, Jy.10 0.01
Tamarack-Custer	Spokane	*59	*57	*59	Sept., 1924 0.25
Tintic Standard	Salt Lake	10.75	10.00	10.75	Jn.24, Jn.29 Q 0.40
Utah-Apex	Boston	6 3/16	6	6⅛	Jy.3, Jy.15, Q 0.35
Western Utah Copper	N. Y. Curb			*18	
IRON					
Bethlehem Steel	New York	39⅜	38⅛	38⅛	July, 1924 1.25
Char. Iron	Detroit			*20	
Char. Iron pfd.	Detroit			*85	
Colorado Fuel & Iron	New York	42	39⅛	40⅛	May, 1921 0.75
Gt. North'n Iron Ore	New York	29	27⅜	25⅝	Ap.11, Ap.30 1.00
Inland Steel	New York	40	38⅜	39⅛	My.15, Jn.1 0.62½
Mesabi Iron	N. Y. Curb	2⅛	2⅛	2⅛	
Replogle Steel	New York	13⅞	13⅛	13⅛	
Republic I. & S.	New York	46⅛	44⅝	45⅜	May, 1921 1.50
Republic I. & S. pfd.	New York			87⅜	Jn.17, Jy.1, Q 1.75
Sloss-Sheffield S. & I.	New York			84⅛	Jn.10, Jn.20 Q 1.50
Sloss-Shef. S.&I. pfd.	New York	91½	84⅛	90⅝	Jn.20, Jy.1, Q 1.75
U. S. Steel	New York	116	113⅜	115	Jn.1, Jn.29, QX 1.75
U. S. Steel pfd.	New York	125	123	125	My.5, My.29,Q 1.75
Virginia I. C. & C.	New York	31	30	31	Jan., 1924 1.50
Virginia I.C.&C.pfd.	New York	73	73	73	Jn.20, Jy.2, 2.50
VANADIUM					
Vanadium Corp.	New York	31¼	28	28¼	Jan., 1921 1.00
ASBESTOS					
Asbestos Corp.	Montreal	83	72	80½	My.1, My.15 Q 1.00
Asbestos Corp., pfd.	Montreal	117	108	110⅞	Ap. 1, Ap. 15, Q 1.50
SULPHUR					
Freeport Texas	New York	18⅛	16⅜	17	Nov., 1919 1.00
Texas Gulf	New York	113	110⅛	110⅞	Jn.1, Jn.15, Q 1.75
DIAMONDS					
De Beers Consol.	New York			21	Ja.6, Fe.2 0.95
PLATINUM					
So. Am. Gold & P.	N. Y. Curb	2⅛	2⅛	2⅛	
MINING, SMELTING, REFINING AND GENERAL					
Amer. Metal	New York	50	47⅞	49	My.19, Jn.1, Q 0.75
Amer. Metal pfd.	New York	115	114	115	My.20, Jn.1, Q 1.75
Amer. Sm. & Ref.	New York	105	102⅞	103⅛	Jy.10, Au.1, Q 1.50
Amer.Sm.&Ref.pfd.	New York	111	110	110⅞	Au.7, Se.1 Q 1.75
Consol. M. & S.	Montreal	85	80½	82½	Jn.30, Jy.15 0.75
Federated Metals	N. Y. Curb	28⅞	28⅞	28⅞	
Newmount Mining	N. Y. Curb	46⅝	45⅝	46⅛	
Southwest Metals	N. Y. Curb			*80	
U. S. Sm. R. & M.	New York	37⅛	35⅞	37⅛	Jy.6, Jy.15 Q 0.75
U.S. Sm. R.&M.pfd.	New York	45¼	45⅛	45⅛	Jy.6, Jy.15 Q 0.87½

* Cents per share. † Bid or asked. Q, Quarterly. SA, Semi-annually. M. Monthly. K, Irregular. I, Initial. X, Includes extra. The first date given is that of the closing of the books; the second that of the payment of the dividend.

Boston quotations courtesy Boston Stock Exchange; Toronto quotations those of the Standard Stock Exchange of Toronto, by courtesy of Arthur E. Moysey & Co.; Spokane, Pohlman Investment Co.; Salt Lake, Stock and Mining Exchange and George H. Watson & Co.; Colorado Springs, Colorado Springs Stock Exchange.

LONDON QUOTATIONS, WEEK ENDED JUNE 20

	High	Low	Last	Date	Per Cent
Aramayo Mines (25 frs.)	77/6	76/10½	77/6	May 1925	5(c)
British Platinum	8/9	8/—	8/6	Feb. 1925	2½
Bwana M'Kubwa	5/9	5/3	5/3		
Camp Bird	2/9	2/—	2/7½		
El Oro	5/9	5/4½	5/6	Nov. 1924	2½*
Esperanza	—/11	—/9	—/10½		
Frontino & Bolivia	11/9	11/6	11/6	July 1925	3¾
Mexican Corporation	12/9	11/9	12/9		
Mexico Mines of El Oro	50/—	42/6	42/6	June 1925	10*
Nechi (pref. 10s.)	1/6	1/3	1/4½	1921-22	25
Oroville Dredging	7/—	6/9	7/—	Dec. 1923	3½
Ouro Preto	5/—	4/9	5/—	May 1925	2½
St. John del Rey	17/—	16/4½	16/9	June 1925	6¼
San Francisco Mines	24/7½	23/6	23/9	June 1925	15
Santa Gertrudis	11/1½	10/3	10/6	July 1920	5
Selukwe (2s. 6d.)	15/—	13/6	13/9	April 1917	6¾
S. American Copper	7/9	7/4½	7/6	Nov. 1917	75
Tanganyika	31/7½	28/9	30/—		
Tomboy	4/7½	4/3	4/3	Feb. 1925	4½
Union Minière du Haut-Katanga (Brussels) 100 Fr	5.145	5.070	5.145	July 1924	80(b)

* Free of British income tax. (b) Belgian francs. (c) Swiss francs.